



# **NAVAL POSTGRADUATE SCHOOL**

**MONTEREY, CALIFORNIA**

## **THESIS**

**WILL CLIMATE CHANGE THE FUTURE OF  
HOMELAND SECURITY?**

by

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September 2016

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**WILL CLIMATE CHANGE THE FUTURE OF HOMELAND SECURITY?**

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## **ABSTRACT**

Drought, melting Arctic ice, ocean acidification, and sea-level rise are all subsectors of climate change. I have identified these as slow-onset disasters. The purpose of this thesis is to determine whether slow-onset disasters are adequately addressed in the homeland security discipline. Risk assessments were performed to determine the level of risk these types of disasters pose to homeland security. The critical infrastructure lifeline sectors—Energy, Communications, Transportation Systems, and Water and Wastewater Systems—were chosen for these assessments because of their identified criticality to national security. The assessments reveal slow-onset disasters pose varying degrees of risk to these sectors. Policy analyses were conducted on the components of the nation’s coordinated approach to homeland security. These reveal the homeland security discipline does not adequately address slow-onset disasters because of internal contradictions. The contradictions are the result of two of the frameworks used in the development of homeland security policies—continuity heuristic and probabilistic thinking. These frameworks lead disaster-consequence planners to consider the probability and magnitude of a disaster based on a retro-focused approach. Based upon my findings, I recommend that possibilistic reasoning (anticipating the worst that could happen), coupled with a future-focused approach, be used to develop homeland security policies that will fully address the emerging threats posed by slow-onset disasters.

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## **LIST OF ACRONYMS AND ABBREVIATIONS**

CFR	Code of Federal Regulations
DHS	U.S. Department of Homeland Security
EO	Executive Order
EMPG	Emergency Management Performance Grant
FA	Food and Agriculture Sector
FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
HMGP	Hazard Mitigation Grant Program
HSGP	Homeland Security Grant Program
HSPD	Homeland Security Presidential Directive
IBSGP	Intercity Bus Security Grant Program
IPR	Intercity Passenger Rail-AMTRAK Program
NIMS	National Incident Management System
NIPP	National Infrastructure Protection Plan
NOAA	National Oceanic and Atmospheric Administration
NRP	National Response Plan
NSGP	Non-Profit Security Grant Program
OPSG	Operation Stone Garden
PDM	Pre-disaster Mitigation Grant
PDD	Presidential Decision Directive
PPD	Presidential Policy Directive
PSGP	Port Security Grant Program
SFI	Strategic Foresight Initiative
SHSP	State Homeland Security Program
SNRA	Strategic National Risk Assessment
SPR	Strategic Petroleum Reserve
THIRA	Threat and Hazard Identification and Risk Assessment
THSGP	Tribal Homeland Security Grant Program
TSGP	Transit Security Grant Program
UASI	Urban Area Security Initiative

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## **EXECUTIVE SUMMARY**

### **A. INTRODUCTION**

Climate change has been an area of concern for the scientific community since the early 1900s. Today, trends associated with this phenomenon are receiving more attention as potential threats to homeland security. This is substantiated by conclusions from the Federal Emergency Management Agency's (FEMA) Strategic Foresight Initiative, the Obama administration's climate change initiatives, and findings in the 2010 and 2014 issues of the *Quadrennial Homeland Security Review*. I have identified a subset of these trends as slow-onset disasters that warrant further attention by disaster consequence planners—drought, melting Arctic ice, ocean acidification, and sea-level rise. There is no single definition for slow-onset disasters. In the absence of a single and widely accepted definition, I have defined a slow-onset disaster as one that takes years to materialize, demonstrates early warning signs, and has cascading consequences beyond primary impact zones.

### **B. SLOW-ONSET DISASTERS AS A THREAT TO HOMELAND SECURITY**

Historical records show that drought, melting Arctic ice, ocean acidification, and sea-level rise are natural and cyclical events that occur throughout the Earth's history. The early inhabitants of the United States escaped the consequences of these events by migrating to other parts of the country. However, population growth and advancements in modern engineering have resulted in the construction of permanent infrastructure in areas that would have previously required a migratory existence. This practice results in an increasing number of people and permanent infrastructure in areas that are most vulnerable to the direct and indirect threats posed by slow-onset disasters. Despite this reality, these types of disasters do not receive much attention from homeland security professionals as a discrete set of threats. This awareness led me to research and ascertain whether or not ocean acidification, melting Arctic ice, drought, and sea-level rise pose a threat to the nation's security.

The nation's critical infrastructure lifeline sectors—Communications, Energy, Transportation Systems, and Water and Wastewater Systems—are the subjects for these assessments. The lifeline sectors were chosen because they are identified by the National Infrastructure Advisory Council as “indispensable services that enable the continuous operation of critical business and government functions, and would risk human health and safety or national and economic security if compromised or not promptly restored.”<sup>1</sup> The results of my assessments reveal ocean acidification poses a low risk and drought poses a high risk to each of the lifeline sectors. Melting Arctic ice poses a medium risk to the Energy Sector but a low risk to the Communications, Transportation Systems, and Water and Wastewater Systems Sectors. Sea-level rise poses a medium risk to the Communications and Transportation Systems Sectors, a high risk to the Water and Wastewater Systems, and a very high risk to the Energy Sector.

### **C. ANALYSES OF HOMELAND SECURITY POLICIES**

I performed policy analyses to determine whether or not slow-onset disasters are adequately addressed by the homeland security discipline. The results reveal the nation's coordinated approach to homeland security includes legislation and policy directives that support achieving the National Preparedness Goal, but they also reveal internal contradictions. For example, the Stafford Act identifies a major disaster as “any natural catastrophe...in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act.”<sup>2</sup> However, the implementing principles for the Stafford Act in the Code of Federal Regulations limits disaster assistance to damages that occurred during “the incident period or was in anticipation of that incident.”<sup>3</sup> This precludes slow-onset disasters from receiving a disaster declaration under the Stafford Act because their slow emergence makes it difficult if not impossible to determine a definite beginning and

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<sup>1</sup> “Strengthening Regional Resilience, Final Report and Recommendations,” National Infrastructure Advisory Council, November 21, 2013, 14, <http://www.dhs.gov/sites/default/files/publications/niac-regional-resilience-final-report-11-21-13-508.pdf>.

<sup>2</sup> *Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act)* Pub. L. No. 93–288, as amended, 42 U.S.C. 5121 et seq., 2, accessed October 7, 2013, [http://www.fema.gov/media-library-data/1383153669955-21f970b19e8eaa67087b7da9f4af706e/stafford\\_act\\_booklet\\_042213\\_508e.pdf](http://www.fema.gov/media-library-data/1383153669955-21f970b19e8eaa67087b7da9f4af706e/stafford_act_booklet_042213_508e.pdf).

<sup>3</sup> Emergency Management and Assistance, 44 CFR §206.32(f) (2002).

ending point. This characteristic also excludes slow-onset disasters from consideration in the Strategic National Risk Assessment. Additionally, only 22 percent of the \$1.6 billion of the Fiscal Year 2016 federal preparedness grants can be used for slow-onset disasters, despite climate change having been identified in the 2015 National Security Strategy as “an urgent and growing threat to our national security...contributing to increased natural disasters.”<sup>4</sup> The remaining funding is limited to protecting our borders, direct counter-terrorism activities, or for activities “where a nexus to terrorism exists.”<sup>5</sup>

#### **D. RECOMMENDATIONS**

My research on the work of three experts in the field of homeland security—Claire Rubin, Donald Kettl, and Kathleen Tierney—reveals the development of homeland security policies follow a retro-focused approach based on the events of the last great disaster. In one case, our experience with natural disasters has led to the expectation that disasters always have a distinct incident period. In the other, the terrorist attacks of 9/11 created an environment in which the availability of resources to counter the threats of terrorism far surpasses those for natural disasters. Federal policies are also framed using probabilistic thinking rather than possibilistic reasoning, and focuses primarily on a “socially constructed likelihood of disaster.”<sup>6</sup> This perspective leads disaster planners to consider the likelihood of an occurrence without also contemplating the worst that could happen (possibilistic reasoning).

FEMA’s Strategic Foresight Initiative and President Obama’s climate change initiatives indicate that slow-onset disasters may yet receive recognition as a subset of climate change warranting further attention. However, the previous frameworks used for the development of homeland security policies must be reconsidered when addressing slow-onset disasters. These disasters require a future-focused rather than a retro-focused

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<sup>4</sup> “National Security Strategy,” The White House, February 2015, 12, [https://www.whitehouse.gov/sites/default/files/docs/2015\\_national\\_security\\_strategy.pdf](https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf).

<sup>5</sup> “Notice of Funding Opportunity, Fiscal Year 2016 Homeland Security Grant Program (HSGP),” U.S. Department of Homeland Security, 2, accessed April 23, 2016, [http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY\\_2016\\_HSGP\\_NOFO\\_FINAL.pdf](http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY_2016_HSGP_NOFO_FINAL.pdf).

<sup>6</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience* (Stanford, CA: Stanford University Press, 2014). Kindle edition.

approach, especially when considering the emerging drivers for change identified by the Strategic Foresight Initiative. Disaster planning must use possibilistic reasoning to anticipate the consequences of slow-onset disasters that span large geographic areas and cross jurisdictional boundaries. This will require planning beyond a local perspective, otherwise “an uncoordinated approach to [climate change] adaptation in the United States would result in a patchwork of activities that may lead to unintended consequences, conflicting mandates, and potential maladaptations.”<sup>7</sup>

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<sup>7</sup> National Research Council of the National Academies of Science, *Adapting to the Impacts of Climate Change* (Washington, DC: The National Academies Press, 2010), 222, [http://www.nap.edu/catalog.php?record\\_id=12783](http://www.nap.edu/catalog.php?record_id=12783).

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Finally, I dedicate this work to my children, Nicole and Bill, and grandchildren, Gabrielle, Caitlin, Tom, Jude, and Manni. May this serve as proof that learning is a lifelong pursuit.

*Etiam stulti ut quieti!*

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## I. INTRODUCTION

Climate change impacts—ranging from more frequent and severe storms, floods, heat waves, and wildfires, to increased risk of asthma attacks and longer allergy seasons—already affecting our security, our economy, and our communities. In 2012 alone, the cost of weather disasters exceeded \$110 billion in the United States, and climate change will only increase the frequency and intensity of these events.

—President Barack Obama

### A. OPENING DISCUSSION

In June 2013, President Obama released his comprehensive plan to reduce the impacts of climate change. State-by-state reports were also published, identifying current and anticipated impacts of extreme weather events related to climate change.<sup>1</sup> Natural disasters, pandemics, and trends associated with climate change are also identified as threats to homeland security in *The 2014 Quadrennial Homeland Security Review*, published on June 18, 2014. The review stated:

Pandemic disease, hurricanes, and other natural disasters not only have the potential to cause severe consequences, including fatalities and economic loss, but also may overwhelm the capacities of critical infrastructure, causing widespread disruption of essential services across the country.<sup>2</sup>

The relationship of these types of events to homeland security is made clearer when viewed from the perspective of the *2010 Quadrennial Homeland Security Review's* definition of homeland security: “A concerted national effort to ensure a homeland that is safe, secure, and resilient against terrorism and other hazards where American interests,

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<sup>1</sup> “State-by-State Reports: President Obama’s Plan to Cut Carbon Pollution and Prepare for Consequences of Climate Change,” The White House, accessed April 4, 2014, <http://www.whitehouse.gov/blog/2013/06/26/state-state-reports-president-obamas-plan-cut-carbon-pollution-and-prepare-consequen#states>.

<sup>2</sup> “The 2014 Quadrennial Homeland Security Review,” U.S. Department of Homeland Security, June 18, 2014, 22, <http://www.dhs.gov/sites/default/files/publications/qhsr/2014-QHSR.pdf>.

aspirations, and way of life can thrive.”<sup>3</sup> Table 1 is a summary of the data presented in the state-by-state reports.

Table 1. Impacts of Extreme Weather Events by Region<sup>4</sup>

Extreme Weather Impacts	Arctic	Great Plains	Midwest	Northeast	Northwest	Pacific Islands	Southeast	Southwest
Melting Arctic Ice	✓							
Ocean Acidification	✓			✓		✓		
Storms / Hurricanes	✓					✓		
Wildfires	✓				✓			✓
Heat Wave	✓	✓	✓	✓			✓	✓
Water Shortage/Drought		✓	✓	✓	✓	✓	✓	✓
Flooding		✓	✓	✓		✓		✓
Health Concerns		✓	✓	✓	✓	✓	✓	✓
Sea Level Rise/Coastal	✓			✓	✓	✓	✓	

## B. PROBLEM STATEMENT

The Intergovernmental Panel on Climate Change Working Group III<sup>5</sup> announced on April 13, 2014, that their findings reveal global efforts to mitigate the results of climate change have not been enough to “avert profound risks in coming decades.”<sup>6</sup> The global consequences of this finding “could produce drastic effects, such as the collapse of ice sheets, a rapid rise in sea levels, difficulty growing enough food, huge die-offs of forests, and the mass extinctions of plant and animal species.”<sup>7</sup> If it is true that we cannot avert these risks, then how equipped are we to address their consequences?

<sup>3</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U.S. Department of Homeland Security, February 2010, 13, <http://www.dhs.gov/sites/default/files/publications/2010-qhsr-report.pdf>.

<sup>4</sup> Adapted from “State-by-State Reports: President Obama’s Plan to Cut Carbon Pollution and Prepare for Consequences of Climate Change,” The White House, accessed April 4, 2014, <http://www.whitehouse.gov/blog/2013/06/26/state-state-reports-president-obamas-plan-cut-carbon-pollution-and-prepare-consequen#states>.

<sup>5</sup> The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. Excerpted from the “IPCC Factsheet: What Is the IPCC?,” accessed April 13, 2014, [http://ipcc.ch/news\\_and\\_events/docs/factsheets/FS\\_what\\_ipcc.pdf](http://ipcc.ch/news_and_events/docs/factsheets/FS_what_ipcc.pdf).

<sup>6</sup> Justin Gillis, “Climate Efforts Falling Short, U.N. Panel Says,” *New York Times*, April 13, 2014, [http://www.nytimes.com/2014/04/14/science/earth/un-climate-panel-warns-speedier-action-is-needed-to-avert-disaster.html?\\_r=0](http://www.nytimes.com/2014/04/14/science/earth/un-climate-panel-warns-speedier-action-is-needed-to-avert-disaster.html?_r=0).

<sup>7</sup> Gillis, “Climate Efforts Falling Short, U.N. Panel Says.”

My subsequent search for an answer to this question led me to identify a subset of extreme weather events from the president's state-by-state reports that share the similar characteristics of slow emergence and cascading consequences beyond their primary impact zones: melting Arctic ice, ocean acidification, water shortage/drought, and sea level rise/coastal flooding. While these events are studied extensively by the scientific community, they have not received much attention from disaster management professionals as a discrete set of threats to our nation. Instead, planning efforts for fast-onset disasters, such as hurricanes, flash floods, tornadoes, earthquakes, and wildfires are the primary subjects for their attention. Further research also indicates no generally accepted definition for slow-emerging disasters is being used within the United States. However, in contrast, these types of events are widely referenced by the international community as slow-onset disasters.

The World Health Organization identifies slow-onset disasters as “disasters that take a long time to produce emergency conditions, for instance natural disasters such as drought or socio-economic decline, which are normally accompanied by early warning signs.”<sup>8</sup> The International Red Cross identifies them as events that “occur over time and slowly deteriorate a society's and a population's capacity to withstand the effects of the hazard or threat.”<sup>9</sup> The definition most often used is that of the United Nations Office for the Coordination of Humanitarian Affairs: “one that does not emerge from a single, distinct event but one that emerges gradually over time, often based on a confluence of different events.”<sup>10</sup> In the absence of a single definition, I define a slow-onset disaster as one that takes years to materialize, demonstrates early warning signs, and has cascading consequences beyond primary impact zones.

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<sup>8</sup> “Definitions: Emergencies,” World Health Organization, accessed January 31, 2015, <http://www.who.int/hac/about/definitions/en/>.

<sup>9</sup> “Introduction to Disaster Preparedness: Disaster Preparedness Training Programme,” International Federation of Red Cross and Red Crescent Societies, 8, accessed July 27, 2014, <http://www.ifrc.org/Global/Publications/disasters/all.pdf>.

<sup>10</sup> “OCHA and Slow-onset Emergencies,” United Nations Office for the Coordination of Humanitarian Affairs, Policy Development and Studies Branch, OCHA Occasional Policy Briefing Series: Brief No. 6, April 29, 2011, 3, [https://docs.unocha.org/sites/dms/Documents/OCHA\\_OPB\\_SlowOnsetEmergencies190411.pdf](https://docs.unocha.org/sites/dms/Documents/OCHA_OPB_SlowOnsetEmergencies190411.pdf).

## **C. RESEARCH QUESTIONS**

I identified slow-onset disasters as a subset of the severe weather events included in Table 1 and conducted further research to answer the overarching question: Are slow-onset disasters adequately addressed within the homeland security discipline? Three questions are asked in order to determine the answer:

- 1) What are the characteristics and consequences of slow-onset disasters?
- 2) Do their consequences rise to the level of a homeland security threat?
- 3) Do current homeland security policies integrate consideration of slow-onset disasters?

## **D. LITERATURE REVIEW**

The purpose of this literature review is to identify sources of information for researching slow-onset disasters, disaster consequence management, and the homeland security discipline. The following are relevant samples of literature that are used for this thesis.

### **1. Disaster Consequence Management Literature**

Several publications were consulted to gain a deeper understanding of the evolution of disaster consequence management in the United States. The *Federal Emergency Management Agency Publication 1* provides a concise history of major events that contributed to the development of the emergency management discipline. This information was then verified by supporting evidence found in Rutherford H. Platt's *Disasters and Democracy: The Politics of Extreme Natural Events*, William L. Waugh's *Living with Hazards Dealing with Disasters: An Introduction to Emergency Management*, and Dennis Mileti's *Disasters by Design*. When viewed from a historical perspective, a correlation between major disasters and changes to legislation, strategies, policies, and practice in disaster consequence management becomes evident. This cause and effect model is primarily based on fast-onset disasters.

Disaster consequence management policies are also influenced by underlying points of view that frame their development. An understanding of three of these frameworks was gained from reading Claire Rubin's "Introduction: 110 Years of Disaster

Response in and Emergency Management in the United States” in *Emergency Management: The American Experience, 1900–2010*, Kathleen Tierney’s *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, and Donald Kettl’s *System Under Stress: The Challenge to 21<sup>st</sup> Century Governance*. The works of these three experts in the field of homeland security reveal the practice of disaster consequence management takes a retro-focused approach and is primarily influenced by social concepts of risk perception and the reactions of policy systems to stress caused by disasters.

## **2. Scientific/Statistical Research**

Data retrieved from the National Archives was also used to verify information related to the development of disaster consequence management within the United States. The Environmental Protection Agency’s Climate Change website contains multiple resources for researching indicators and the projected outcomes and impacts of climate change. A copy of the report *Climate Change Indicators in the United States, 2012* was used to identify additional sources for research material on slow-onset disasters. Other information for identifying these sources was gleaned from the White House’s *State-by-State Reports*, and the National Oceanic and Atmospheric Administration’s (NOAA) data on billion dollar disasters caused by severe weather as a result of climate change. Information on drought conditions was taken from the University of Nebraska-Lincoln’s National Drought Mitigation Center and the U.S. Drought Portal websites. Drought disaster declarations under the Robert T. Stafford were identified in the FEMA Disaster Declarations Summary—Open Government Dataset.

Climate Central ([www.climatecentral.org](http://www.climatecentral.org)) is the website run by an independent organization of scientists and journalists involved with researching and reporting on climate change and its impact on the American public. This website provides valuable information on the phenomenon of sea-level rise in its Surging Seas analysis module and collection of climate change research material. The National Snow and Data Center website was used to retrieve data, graphs, and maps to gain an understanding of the extent of melting Arctic ice and threats to the Alaska population’s economic, social, and

cultural stability. Research on ocean acidification was conducted using the University of Washington's Environmental Visualization tool and NOAA's website.

### **3. Homeland Security Policies for Slow-Onset Disasters**

Research was also conducted to determine the level of policymaker recognition of the slow-onset disaster phenomenon and the status of policies and programs related to their occurrence. In the case of ocean acidification, the Congressional Research Service publication *Ocean Acidification* by Upton and Folger states “legislative attention to ocean acidification has focused on authorizing, funding, and coordinating research to increase knowledge about ocean acidification and its potential effects on marine ecosystems.”<sup>11</sup>

Information on melting ice in the Arctic was gathered from *Changes in the Arctic: Background and Issues for Congress*. The ramifications of melting Arctic sea ice were identified for the following areas: weather patterns, endangered species (on-shore and aquatic animals), access to newly available mineral and oil reserves, potential foreign territorial claims for emerging land mass, commercial shipping, and national security.<sup>12</sup> All of these have the potential to cause significant negative impacts on the economy, health, and culture of the indigenous population.

In spite of the growing concerns regarding drought conditions in the United States, no national comprehensive drought strategy exists as they do for flooding, wild fires, and hurricanes. The reason is identified in the Congressional Research Service report, *Drought in the United States: Causes and Issues for Congress*, which states: “developing a national policy would be challenging because of split federal and nonfederal responsibilities; the existing patchwork of federal programs; and differences in regional conditions, risks, and available responses.”<sup>13</sup>

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<sup>11</sup> Harold F. Upton and Peter Folger, *Ocean Acidification* (CRS Report No. R40143) (Washington, DC: Congressional Research Service, 2013), 13, <http://www.fas.org/sgp/crs/misc/R40143.pdf>.

<sup>12</sup> Ronald O'Rourke, *Changes in the Arctic: Background and Issues for Congress* (CRS Report No. R41153) (Washington, DC: Congressional Research Service, 2014), <http://www.fas.org/sgp/crs/misc/R41153.pdf>.

<sup>13</sup> Peter Folger, Betsy A. Cody and Nicole T. Carter, *Drought in the United States: Causes and Issues for Congress* (CRS Report No. RL34580) (Washington, DC: Congressional Research Service, 2013), 1, September 21, 2013, <http://www.fas.org/sgp/crs/misc/RL34580.pdf>.

Research was also performed on the Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Homeland Security Act of 2002—two of the primary enabling legislations for disaster consequence management in the United States. These legislations and their ancillary policies and programs were analyzed to determine their applicability to slow-onset disasters.

## **E. RESEARCH DESIGN**

### **(1) Object/Sample**

The subject of this thesis is to conduct research on four slow-onset disasters—melting Arctic ice, ocean acidification, water shortage/drought, and sea level rise/coastal flooding—that comprise a subset of the larger climate change phenomenon. I explore their characteristics and consequences, whether they rise to the level of a homeland security threat, and how they are addressed by disaster management policies.

### **(2) Selection**

Melting Arctic ice, ocean acidification, water shortage/drought, and sea-level rise/coastal flooding were selected for further research because they already impact the Continental United States and are less studied by disaster management planners. The National Critical Infrastructure Lifeline Sectors were chosen for an assessment to determine the level of risk slow-onset disasters pose to these sectors, due to the dire consequences a failure of one or more these sectors poses to national security. The Federal Emergency Management Agency's risk assessment process is used because this evaluation tool is: 1) broadly used in the field of disaster management for hazard identification, vulnerability, and risk assessments, and 2) customizable to the subject of this thesis.

### **(3) Limits**

The focus of this thesis is limited to naturally occurring events within the Continental United States and homeland security policies that are in place to address disaster consequence management. I use a standardized and generally accepted risk assessment tool to evaluate these events' potential to be threats to homeland security.

Throughout this thesis, references to drought include issues related to water shortage, and those related to sea-level rise include coastal flooding.

#### (4) Data Sources

Open-source, secondary literature, and published data and statistics are used as data sources.

#### (5) Type and Mode of Analysis

An exploratory study was undertaken to identify the characteristics and causes, consequences, and implications of slow-onset disasters for homeland security. Next, the 16 Critical Infrastructure Sectors (Figure 1), including those identified as lifeline sectors, were reviewed to gain an understanding of their importance to the nation's security. This was followed by a risk assessment to ascertain the vulnerability of the lifeline sectors to ocean acidification, melting Arctic ice, sea-level rise, and drought. The results of the assessment led to an analysis of current disaster policies to determine the evolution of homeland security policies in the United States and the relevance of these policies to slow-onset disasters. Next, additional research was conducted to identify the underlying frameworks that are used to develop homeland security policies and to determine whether or not there are indicators that slow-onset disasters are initiating changes within the homeland security discipline.

#### (6) Output

The output of this thesis is the compilation of the result of relevant research, risk assessments, and policy analyses to provide a deeper understanding of the dynamics of slow-onset disasters and their implications for homeland security policies.

### **F. UPCOMING CHAPTERS**

Chapter II provides a background on slow-onset disasters, their characteristics and consequences, and the emerging threats they pose to the nation. An overview of the National Critical Infrastructure Sectors is the subject of Chapter III, while Chapter IV presents the results of my risk assessment to determine whether or not slow-onset



disasters pose a threat to these sectors. Chapter V provides an analysis of current and emerging homeland security policies and their relevance to slow-onset disasters. Three frameworks used in the development of homeland security policies are discussed in Chapter VI. Finally, Chapter VII presents findings, recommendations, and areas for future research on slow-onset disasters and their implications for the homeland security discipline.

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## II. A PRIMER ON SLOW-ONSET DISASTERS

Where on the face of the earth can we find a spot, on which close investigation will not discover signs of that endless cycle of change, to which this earth has been, is, and will be subjected?

—Charles Darwin

### A. INTRODUCTION

Historical records show melting Arctic ice, ocean acidification, sea-level rise, and drought are part of the Earth’s natural formative process and have occurred throughout its history. Early inhabitants of the Continental United States escaped similar events by migrating such as the native populations of the Southwest and the central and lower Mississippi Valley did during pre-historic megadroughts.<sup>14</sup> Studies have also shown that migration was an adaptive response for the peoples of the Arctic region for thousands of years.<sup>15</sup> Were it not for the threats they pose to our modern way of life, these naturally occurring events could remain an area of study primarily within the realm of the scientific community.

Population growth in the United States coupled with advancement in modern engineering has made it possible for permanent infrastructure to be constructed in areas that would previously have required a migratory existence. For instance, transportation, water management systems, levees, dredging, and landfills have resulted in the development of vast areas that had previously been inhabitable. Advances in irrigation and modern growing practices have also allowed the expansion of agriculture into areas that were once deserts. Modern fishing vessels, global positioning systems (GPS), and fish finders have enhanced the capabilities of the fishing fleets that support the seafood industry in the United States. Paradoxically, these advances have also increased the

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<sup>14</sup> Edward R. Cook et al., “North American Drought: Reconstructions, Causes, and Consequences,” *Earth-Science Reviews* 81, (2007): 93–134, <http://www.sciencedirect.com/science/article/pii/S0012825206001784>.

<sup>15</sup> Elizabeth Ferris, *A Complex Constellation: Displacement, Climate Change and Arctic Peoples* (Washington, DC: Brookings-LSE, Project on Internal Displacement, 2013), 4, <http://www.brookings.edu/~media/research/files/papers/2013/1/30-arctic-ferris/30-arctic-ferris-paper.pdf>.

vulnerability of communities to the direct and indirect threats posed by slow-onset disasters.

This chapter provides documented information that slow-onset disasters threaten “American interests, aspirations, and way of life.”<sup>16</sup> Some data is predictive in nature, based on emerging trends that indicate their potential impacts to the cultural, social, and economic stability of the American people. Other information is historical and documents events that have already occurred. The findings presented in this chapter indicate that the consequences of slow-onset disasters warrant further attention as posing significant threats to our nation’s security.

## **B. WHAT ARE SLOW-ONSET DISASTERS AND WHY SHOULD WE CARE?**

### **1. Ocean Acidification**

The world’s oceans absorb approximately 25 percent of the carbon dioxide (CO<sub>2</sub>) that is present in the atmosphere. As this concentration increases so does the level of CO<sub>2</sub> in the oceans. Higher levels of CO<sub>2</sub> in the oceans lowers pH levels and increases acidity. This increased acidity negatively impacts calcifying species such as “oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton.”<sup>17</sup> These organisms are important links in the ocean’s food chain and their loss threatens not only marine life who depend on it for food, but also the lives of those who depend on it for their sustenance and livelihood.<sup>18</sup>

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<sup>16</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U. S. Department of Homeland Security, 13.

<sup>17</sup> “What Is Ocean Acidification?,” National Oceanic and Atmospheric Administration, Pacific Marine Environmental Laboratory, accessed February 1, 2015, <http://pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F>.

<sup>18</sup> Ibid.

Oceanographic studies show evidence of ocean acidification dating back to the Paleocene–Eocene Thermal Maximum event.<sup>19</sup> Scientists credit this as the cause of “a sudden ‘dissolution event’ in which so much of the shelled sea life disappeared that the sediment changed from primarily white calcium carbonate ‘chalk’ to red-brown mud.”<sup>20</sup> The implication of this finding is that “seawater became so corrosive that it ate away at the shells, along with other species with calcium carbonate in their bodies. It took hundreds of thousands of years for the oceans to recover from this crisis, and for the sea floor to turn from red back to white.”<sup>21</sup>

Other studies reveal “in the past 200 years alone, ocean water has become 30 percent more acidic—faster than any known change in ocean chemistry in the last 50 million years.”<sup>22</sup> Additionally, polar ice core samples from Greenland and Antarctica show the acidity of the oceans is the highest it has been in the last 800,000 years.<sup>23</sup> This in part is exacerbated by waste from industrial and agricultural enterprises, either introduced by direct runoff from adjacent facilities in heavily populated coastal areas or carried long distances by rivers flowing into estuaries and coastal waters.<sup>24</sup>

Although ocean acidification is a relatively new area of study, research has shown that “while the ultimate consequences are still unknown, there is a risk of ecosystem changes that threaten coral reefs, fisheries, protected species, and other natural resources

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<sup>19</sup> “The Paleocene–Eocene Thermal Maximum (PETM) is one of the most intense and abrupt intervals of global warming in the geological record. It occurred around 56 million years ago, at the boundary between the Paleocene and Eocene epochs.” Phil Jardine, “Patterns in Palaeontology: The Paleocene–Eocene Thermal Maximum,” accessed January 24, 2015, <http://www.palaeontologyonline.com/articles/2011/the-paleocene-eocene-thermal-maximum/>.

<sup>20</sup> “Ocean Acidification,” Smithsonian National Museum of Natural History, accessed January 24, 2015, <http://ocean.si.edu/ocean-acidification>.

<sup>21</sup> Carl Zimmer, “An Ominous Warning on the Effects of Ocean Acidification,” Yale environment360, accessed January 24, 2015, [http://e360.yale.edu/feature/an\\_ominous\\_warning\\_on\\_the\\_effects\\_of\\_ocean\\_acidification/2241/](http://e360.yale.edu/feature/an_ominous_warning_on_the_effects_of_ocean_acidification/2241/).

<sup>22</sup> “Ocean Acidification,” Smithsonian National Museum of Natural History.

<sup>23</sup> “Ocean Acidification,” Woods Hole Oceanographic Institute, accessed November 17, 2014, <http://www.whoi.edu/main/topic/ocean-acidification>.

<sup>24</sup> Hedia Adelman and Laura Whitely Binder, eds., *Ocean Acidification: From Knowledge to Action, Washington State’s Strategic Response* (Publication no. 12–01-015) (Olympia, WA: Washington State Blue Ribbon Panel on Ocean Acidification, 2012), 12–13, [http://pmel.noaa.gov/co2/files/wa\\_state\\_blue\\_ribbon\\_panel\\_oa\\_11-27-2012.pdf](http://pmel.noaa.gov/co2/files/wa_state_blue_ribbon_panel_oa_11-27-2012.pdf).

of value to society.”<sup>25</sup> Based on statistics published in the *Fisheries of the United States 2013*,<sup>26</sup> this value to society in the United States is an estimated \$86.5 billion spent on fishery products including \$57.9 billion at food service establishments. Overall, in 2013, “the commercial marine fishing industry contributed \$43.6 billion (in value added) to the U.S. Gross National Product.”<sup>27</sup>

Alaska’s fisheries produce “almost 50% of the nation’s seafood harvest.”<sup>28</sup> This geographic area is also of major importance to Alaskan populations because “the Bering Sea is directly or indirectly the source of over 25 million pounds of subsistence food for Alaska residents, primarily Alaska natives in small coastal communities.”<sup>29</sup>

Ocean acidification poses not only a threat to the food supply but also the cultural stability of Alaskan natives. Subsistence harvesting has been practiced for thousands of years and is an important part of the cultural identity of the indigenous population. They “have relied upon the traditional harvest of wild foods for thousands of years and have passed this way of life, its culture, and values down through generations.”<sup>30</sup>

Ocean acidification also threatens sea life along the Pacific coast of the United States. A report published by the Washington State Ribbon Panel on Ocean Acidification discusses what this threat means to Washington’s “marine economy, cultures, and environment.”<sup>31</sup> According to the report, the seafood industry generates 42,000 jobs and contributes more than \$1.7 billion in gross profits and employment in Washington.

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<sup>25</sup> “Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean,” National Research Council of the National Academies (Washington, DC: The National Academies Press, 2010), 96, accessed November 17, 2014, [http://www.nap.edu/download.php?record\\_id=12904](http://www.nap.edu/download.php?record_id=12904).

<sup>26</sup> Alan Lowther and Michael Liddel, eds. *Fisheries of the United States 2013* (Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service Office of Science and Technology, 2014), v, [http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus13/01\\_front2013.pdf](http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus13/01_front2013.pdf).

<sup>27</sup> Ibid.

<sup>28</sup> Adrienne J. Sutton, ed. *NOAA Ocean and Great Lakes Acidification Research Plan* (NOAA Ocean Acidification Steering Committee, 2010), 32, [http://www.pmel.noaa.gov/co2/files/feel3500\\_without\\_budget\\_rfs.pdf](http://www.pmel.noaa.gov/co2/files/feel3500_without_budget_rfs.pdf).

<sup>29</sup> Ibid.

<sup>30</sup> “Federal Subsistence Management Program,” U.S. Department of the Interior, accessed September 10, 2015, <https://www.doi.gov/subsistence>.

<sup>31</sup> Adelsman and Binder, eds., *Ocean Acidification*, 3.

Additionally, \$3 million was collected for state licenses to harvest wild shellfish, and recreational oyster and clam harvesters contributed an additional \$27 million to the local economy.<sup>32</sup>

In 2007, Oregon's oyster larvae were dying by the millions both in Willapa Bay and in hatchery tanks. An investigation into the cause revealed ocean acidification conditions that exist in colder waters at the ocean bottom were rising closer to the surface along the West Coast upwelling zones.<sup>33</sup> This phenomenon also threatens the oyster and abalone industries in California.

According to an article published in 2011, the coast of Maine produces more than 105 million pounds of lobster valued at more than \$334 million along with 33 million pounds of other types of shellfish with an estimated market value of \$22 million.<sup>34</sup> The same article also identified a potential loss of \$1 billion for the Maine economy related to ocean acidification.<sup>35</sup> This threat is not limited to the Maine seafood industry. It will impact all the communities along the Gulf of Maine, the mid-Atlantic region, and the Gulf Coast region. In 2012, the Gulf Coast—Alabama, Louisiana, Mississippi, Texas, and West Florida—generated over \$21.82 billion in annual sales from the sea food industry that also supported 159.9 million jobs.<sup>36</sup>

## **2. Melting Arctic Ice**

Historical data is not available for the impacts melting Arctic ice has on human systems. However, ample research is available for the expansion and contraction of sea

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<sup>32</sup> Adelman and Binder, eds., *Ocean Acidification*, 3–5.

<sup>33</sup> “Upwelling occurs when winds blowing across the ocean surface often push water away from an area. When this occurs, water rises up from beneath the surface to replace the diverging surface water. This process is known as upwelling,” National Oceanic and Atmospheric Administration, “NOAA Ocean Service Education,” accessed January 26, 2015, <http://oceanservice.noaa.gov/education/kits/currents/03coastal4.html>.

<sup>34</sup> “Ocean Acidification: What It Is and Why It Matters Along the Maine Coast,” The Island Institute, accessed February 8, 2015, [www.islandinstitute.org/files/Ocean+Acidification.pdf/853/](http://www.islandinstitute.org/files/Ocean+Acidification.pdf/853/).

<sup>35</sup> Ibid.

<sup>36</sup> “Fisheries Economics of the U.S. 2012, Gulf of Mexico,” National Oceanic and Atmospheric Administration, Office of Science and Technology, National Marine Fisheries Service, accessed January 24, 2015. 121. [http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012\\_GulfMexico.pdf](http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012_GulfMexico.pdf).

ice in the Arctic. Using proxy data,<sup>37</sup> paleoclimatologists have determined that large ice sheets formed in the polar regions after “the onset of a long-term climatic cooling that followed the Paleocene–Eocene Thermal Maximum.”<sup>38</sup> Further study of proxy data and satellite images also show Arctic sea ice grows and contracts based on seasonal changes. The ice reaches its maximum extent in March and then begins a melting process that continues until the start of winter in September. Studies from the mid-19<sup>th</sup> century indicate the Arctic region “reached the highest temperatures in at least the last two thousand years.”<sup>39</sup> Other studies indicate that the Arctic could have ice-free summers by the year 2040.<sup>40</sup>

This melting of the ice fields has far-reaching ramifications beyond the Arctic region as it contributes to sea-level rise and increases the frequency of extreme weather events. Sea level increases when water from the ice melt enters the ocean.<sup>41</sup> A larger expanse of the ocean surface is exposed when the ice fields melt, and as the sun warms this darker unexposed area, the water molecules expand and also contribute to sea-level rise. This phenomenon accounts for 40 percent of the sea-level rise over the last 35 years.<sup>42</sup>

The absorption of heat and its eventual release into the atmosphere is thought to be affecting the North American jet stream, which determines our weather patterns. This is believed to result in extreme snowfall, hurricanes, heat waves, and drought. Evidence

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<sup>37</sup> Proxy data are “natural clues to past climate that are buried in sediments at the bottom of the oceans, locked in coral reefs, frozen in glaciers and ice caps, or preserved in the rings of trees.” “Introduction to Paleoclimatology,” National Oceanic and Atmospheric Administration, accessed January 24, 2015, [http://www.ncdc.noaa.gov/paleo/primer\\_study.html](http://www.ncdc.noaa.gov/paleo/primer_study.html)

<sup>38</sup> Leonid Polyak et al., “History of Sea Ice in the Arctic,” *Quaternary Science Reviews* 29 (2010): 1773, accessed January 10, 2015, [http://bprc.osu.edu/geo/publications/polyak\\_et\\_al\\_seaice\\_QSR\\_10.pdf](http://bprc.osu.edu/geo/publications/polyak_et_al_seaice_QSR_10.pdf).

<sup>39</sup> *Ibid.*, 1772.

<sup>40</sup> James E. Overland and Muyin Wang, “When Will the Summer Arctic Be Nearly Sea Ice Free?,” *Geophysical Research Letters* 40, (2013), 2097–2101, accessed January 10, 2015, <http://onlinelibrary.wiley.com/doi/10.1002/grl.50316/full>.

<sup>41</sup> Barry G. Rogers, “How Might Sea Level Be Affected by Changes in Land Ice,” National Oceanic and Atmospheric Administration, accessed January 25, 2015, [http://www.arctic.noaa.gov/essay\\_barry.html](http://www.arctic.noaa.gov/essay_barry.html).

<sup>42</sup> Jerry M. Melillo, Terese (T. C.) Richmond, and Gary W. Yohe, eds., *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*. (Washington, DC: U.S. Global Change Research Program, 2014), 60, [http://s3.amazonaws.com/nca2014/low/NCA3\\_Highlights\\_LowRes.pdf?download=1](http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download=1).



to support this theory was recently published in the article “Climate Forcing of Unprecedented Intense-Hurricane Activity in the Last 2000 Years” that links sea surface temperature rise with intense hurricanes.<sup>43</sup>

The people of Alaska are already experiencing negative consequences resulting from melting ice fields. Hunting ranges of the indigenous populations have been greatly reduced and the “harvesting of animals is likely to become riskier and less predictable which may increase food insecurity.”<sup>44</sup> Warmer temperatures in the region are also causing erosion and coastal flooding and thawing permafrost. According to a report published by the Brookings Institution in January 2013, these threats impact 31 Alaskan communities with 12 facing relocation.<sup>45</sup> Thawing permafrost threatens infrastructures such as homes, schools, hospitals, railroads, highways, and airstrips. The Environmental Protection Agency reports that approximately 100,000 people live in areas that are susceptible to the loss of permafrost.<sup>46</sup>

### **3. Sea Level Rise**

American communities outside of Alaska are also facing the possibility of forced relocation due to another slow-onset disaster. Since the early 1900s, sea levels along the U.S. coastlines have been rising.<sup>47</sup> This phenomenon is caused by a number of factors including melting Arctic and Antarctic ice fields, the rising ocean temperatures, and the shifting of tectonic plates caused by receding glaciers.<sup>48</sup> A 2009 study reveals it “has been estimated that 3 feet of sea level rise (within the range of projections for this

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<sup>43</sup> Jeffrey P. Donnelly et al., “Climate Forcing of Unprecedented Intense Hurricane Activity in the Last 2000 Years,” *Earth’s Future* 3, no. 2 (February 2015): 49–65, doi:10.1002/2014EF000274, <http://onlinelibrary.wiley.com/enhanced/doi/10.1002/2014EF000274/>.

<sup>44</sup> O’Rourke, *Changes in the Arctic: Background and Issues for Congress*, 39.

<sup>45</sup> Robin Bronen, *Climate-Induced Displacement of Alaska Native Communities*. (Washington, DC: Brookings-Bern Project on Internal Displacement, 2013), 9–18, <http://www.brookings.edu/~media/research/files/papers/2013/1/30-arctic-alaska-bronen/30-climate-alaska-bronen-paper.pdf>.

<sup>46</sup> “Climate Change Impacts and Adaptation,” United States Environmental Protection Agency, accessed March 6, 2015, <http://www.epa.gov/climatechange/impacts-adaptation/alaska.html>.

<sup>47</sup> “Is Sea Level Rising,” National Oceanic and Atmospheric Administration, accessed May 21, 2016, <http://oceanservice.noaa.gov/facts/sealevel.html>.

<sup>48</sup> “Frequently Asked Questions: What Is Sea Level?,” National Oceanic and Atmospheric Administration, accessed March 6, 2015, <http://tidesandcurrents.noaa.gov/sltrends/faq.htm#q1>.

century) would inundate about 65 percent of the coastal marshlands and swamps in the contiguous United States.”<sup>49</sup> This increase in sea level will also impact barrier islands that provide coastal communities protection against hurricanes. Further study indicates that by the end of this century, coastal flooding will threaten more than dry land and will also impact “some 3 million acres of roads, bridges, commercial buildings, military bases, agricultural lands, toxic waste dumps, schools, hospitals, and more.”<sup>50</sup>

The 2014 *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment* reports that 164 million people reside in coastal counties, and this number grows by 1.2 million each year.<sup>51</sup>

Cumulative costs to the economy of responding to sea level rise and flooding events alone could be as high as \$325 billion by 2100 for 4 feet of sea level rise, with \$130 billion expected to be incurred in Florida and \$88 billion in the North Atlantic region. The projected costs associated with one foot of sea level rise by 2100 are roughly \$200 billion. These figures do not include losses of valuable ecosystem services, as well as indirect losses from business disruption, lost economic activity, impacts on economic growth, or other non-market losses.<sup>52</sup>

Data gleaned from Climate Central’s Surging Seas online analysis tool reveals the value of property located in areas less than 4 feet below the high-tide level is \$657 billion.<sup>53</sup> At risk within these areas are 3.37 million people, 1.82 million homes, and 10.17 million acres of land. Given these statistics, disaster management planners now have to consider that

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<sup>49</sup> Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States*. (New York, NY: Cambridge University Press, 2009), 82, <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>.

<sup>50</sup> Ben Strauss, Claudia Tebaldi, and Remik Ziemlinski, “Surging Seas: Sea Level Rise, Storms, and Global Warming’s Threat to the U.S. Coast,” Climate Central, 5, accessed November 29, 2014, <http://slr.s3.amazonaws.com/SurgingSeas.pdf>.

<sup>51</sup> Jerry M. Melillo, Terese (T. C.) Richmond, and Gary W. Yohe, eds., *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*. (Washington, DC: U.S. Global Change Research Program, 2014), 88, [http://s3.amazonaws.com/nca2014/low/NCA3\\_Highlights\\_LowRes.pdf?download=1](http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download=1).

<sup>52</sup> Ibid., 91.

<sup>53</sup> Data was compiled based on information downloaded from Climate Central’s Surging Seas Sea Level Rise analysis tool available at <http://sealevel.climatecentral.org/>. This tool contains data for the 22 coastal states.

The ocean will flood areas that are currently populated, and it will contaminate the ground water of many areas that are close to the new coast line but not yet flooded. In the first case, populations will have to migrate or drown; in the second, they will lose significant agricultural productivity.<sup>54</sup>

#### **4. Drought**

Drought is defined by the National Weather Service as “a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people.”<sup>55</sup> The impact of drought results in both direct and indirect consequences. For instance, the direct impact of a reduction in harvested crops results in the indirect consequence of loss of revenue for farmers, reduction in tax revenues for the affected community, and increased food prices.<sup>56</sup>

Drought is the most familiar and studied of the slow-onset disasters. Paleoanthropologists and archaeologists credit historical megadroughts as the catalyst for the mass migration of the Pueblo people in the Southwestern United States during the 13<sup>th</sup> century, and the native population in the central and lower Mississippi Valley in the 14<sup>th</sup> through 16<sup>th</sup> centuries.<sup>57</sup>

During the 1930s, four separate drought events occurred in such rapid succession that the impacted areas were unable to recover between occurrences. This resulted in what is known as the Dust Bowl. Although the agricultural sector of the Great Plains was primarily impacted, the cascading effects of the Dust Bowl also “contributed to the Great

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<sup>54</sup> Rick Bissell, *Preparedness and Response for Catastrophic Disasters* (Boca Raton, FL: CRC Press, 2013), 17.

<sup>55</sup> “Drought: Public Fact Sheet,” National Oceanic and Atmospheric Administration, National Weather Service, May 2008, accessed December 10, 2013, <http://www.nws.noaa.gov/os/brochures/climate/DroughtPublic2.pdf>.

<sup>56</sup> Donald A. Wilhite, Mark D. Svoboda, and Michael J. Hayes, “Understanding the Complex Impacts of Drought: A Key to Enhancing Drought Mitigation and Preparedness,” *Water Resources Management*, 21 (2007), 765, <http://www.geo.utexas.edu/courses/387h/Lectures/Drought.pdf>.

<sup>57</sup> Cook et al., “North American Drought: Reconstructions, Causes, and Consequences.”

Depression's bank closures, business losses, [and] increased unemployment.”<sup>58</sup> Millions of people were forced to relocate in search of work, often coming into conflict with the existing population in competition for limited jobs.<sup>59</sup> Additionally, the poverty and high unemployment rate of the migrants overloaded local relief efforts and public health systems. It is reported that \$525 million were expended in 1934 for the government's relief efforts to alleviate the impacts of the Dust Bowl and the accompanying Great Depression.<sup>60</sup>

Other droughts of note occurred during the 1950s and 1980s. The 1950s drought lasted for five years and was primarily located in the Great Plains and the Southwest. This severely impacted the agricultural sector with half of the normal crop yield being lost. In the period from 1987 to 1989, drought conditions existed in 36 percent of the United States. Damages as a result of this three-year event are estimated to be \$39 billion. More recent events indicate that drought will have dire consequences with researchers predicting “the mean state of drought in the late 21st century over the Central Plains and Southwest will likely exceed even the most severe megadrought periods of the Medieval era.”<sup>61</sup>

Drought conditions fluctuated across the Continental United States in the period between 2000 and 2014. By the end of 2013, losses from drought (\$102 billion/461 deaths) were surpassed only by severe storms including tornado and hail damage (\$110 billion/927 deaths) and tropical cyclones (\$414 billion/2,627 deaths).<sup>62</sup> Disaster losses

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<sup>58</sup> “Drought in the Dust Bowl Years,” University of Nebraska-Lincoln, National Drought Mitigation Center, accessed February 1, 2015, <http://drought.unl.edu/DroughtBasics/DustBowl/DroughtintheDustBowlYears.aspx>.

<sup>59</sup> Ibid.

<sup>60</sup> “The Dust Bowl's Legacy,” University of Nebraska-Lincoln, National Drought Mitigation Center, accessed February 1, 2015, <http://drought.unl.edu/DroughtBasics/DustBowl/TheDustBowlsLegacy.aspx>.

<sup>61</sup> Benjamin I. Cook, Toby R. Ault, and Jason E. Smerdon, “Unprecedented 21st Century Drought Risk in the American Southwest and Central Plains,” *Science Advances* 1, no. 1 (2015): 6, doi: 10.1126/sciadv.1400082.

<sup>62</sup> Compiled with data from “Billion-Dollar Weather/Climate Disasters: Table of Events,” National Oceanic and Atmospheric Administration, National Climatic Data Center, accessed April 26, 2015, <http://www.ncdc.noaa.gov/billions/events>.

for 2014 were not published at the time of this research and, therefore, are not included. Table 2 includes drought highlights for the period between 2000 and 2013.

Table 2. Drought Impacts for the Years 2000–2013<sup>63</sup>

Year	Impact
2000	<ul style="list-style-type: none"> <li>• Drought conditions are reported to be as extensive as the major droughts of the past forty years.</li> </ul>
2001	<ul style="list-style-type: none"> <li>• Reported to be the thirty-ninth driest period out of 107 years.</li> <li>• The South Carolina Forestry Commission reported that “the drought contributed to the second worst southern pine beetle outbreak since records began in the early 1960s, with timber losses due to the beetles estimated at \$76 million during 2001.”</li> </ul>
2007	<ul style="list-style-type: none"> <li>• “The Tennessee Valley Authority shut down Brown's Ferry Number 2 nuclear power plant in August due to inadequate streamflow needed to cool the reactor.”</li> </ul>
2008	<ul style="list-style-type: none"> <li>• First statewide drought declaration since 1991 issued in California.</li> <li>• 100 percent of California's and 52 percent of Oregon's pasture and range land classified as poor to very poor condition.</li> <li>• “Cotton producers in southern Texas had already lost nearly their entire crop.”</li> </ul>
2010	<ul style="list-style-type: none"> <li>• The Bureau of Reclamation reports Lake Mead's water level is the lowest since the 1930s.</li> <li>• Dry conditions in the Upper Colorado River Basin threatens the water supply for Colorado, Utah, Wyoming, New Mexico, Arizona, California, Nevada and Mexico under the Colorado River Compact.</li> </ul>
2012	<ul style="list-style-type: none"> <li>• Drought conditions across the continental U.S. peaked at 65.5 percent in September and ended the year at 61.1 percent.</li> <li>• Drought conditions in the agricultural areas severely reduced corn and soybean yield.</li> </ul>
2013	<ul style="list-style-type: none"> <li>• Significant recovery from the 2012 drought occurred in some areas of the U.S.</li> <li>• California experiences the driest calendar year in the 1895-2013 record.</li> </ul>
2014	<ul style="list-style-type: none"> <li>• Multi-year drought in California results in “diminished reservoirs, low stream flows, dried out wells, and ravaged crop and rangeland.”</li> <li>• Texas experiences its fourth consecutive year of drier than normal conditions.</li> </ul>

<sup>63</sup> Adapted from “State of the Climate,” NOAA National Centers for Environmental Information, <http://www.ncdc.noaa.gov/sotc/>.

Daniel Griffin and Kevin J. Anchukaitis's study on the 2012–2014 California drought reveals “the current event is the most severe drought in the last 1,200 years, with single year (2014) and accumulated moisture deficits worse than any previous continuous span of dry years.”<sup>64</sup> According to a University of California, Davis study:

The resulting net water shortage of 1.6 million acre-feet will cause losses of \$810 million in crop revenue and \$203 million in dairy and other livestock value, plus additional groundwater pumping costs of \$454 million. These direct costs to agriculture total \$1.5 billion. The total statewide economic cost of the 2014 drought is \$2.2 billion, with a total loss of 17,100 seasonal and part-time jobs.<sup>65</sup>

The California drought has cascading impacts that reach far beyond the state's borders. In 2014, agriculture products from the state “accounted for accounted for 60 percent of the U.S. production for fresh-market vegetables, and 73 percent of processed vegetables”<sup>66</sup> Drought has a significant impact on the economy of the United States as agricultural and livestock losses demonstrate. However, dwindling water supplies also threaten the National Critical Infrastructure Sectors.<sup>67</sup>

## C. CONCLUSION

This chapter provides a background on slow-onset disasters and their impacts to communities within the Continental United States. Ocean acidification, melting Arctic ice, sea-level rise, and drought display the characteristics presented in the definition of a slow-onset disaster—they take years to materialize, demonstrate early warning signs, and have cascading consequences beyond primary impact zones. As shown in this chapter, the occurrence of any one of these hazards poses a significant threat to the social, cultural, and economic stability of the impacted population. However, further evaluation

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<sup>64</sup> Daniel Griffin and Kevin J. Anchukaitis, “How Unusual Is the 2012–2014 California Drought?,” *Geophysical Research Letters* 41, no. 24 (December 28, 2014): 9017, <http://onlinelibrary.wiley.com.libproxy.nps.edu/dow/10.1002/2014GL062433/full>.

<sup>65</sup> Richard Howitt et al., *Economic Analysis of the 2014 Drought for California Agriculture* (Davis, CA: Center for Watershed Sciences, University of California-Davis, 2014), ii, [https://watershed.ucdavis.edu/files/biblio/DroughtReport\\_23July2014\\_0.pdf](https://watershed.ucdavis.edu/files/biblio/DroughtReport_23July2014_0.pdf).

<sup>66</sup> “Rain Needed to Bust the Drought,” Climate Central, November 12, 2015, <http://www.climatecentral.org/gallery/maps/rain-needed-to-bust-the-drought>.

<sup>67</sup> “Water-Specific Plan: An Annex to the National Infrastructure Protection Plan,” 2010, U.S. Department of Homeland Security, 67–68, <http://www.dhs.gov/xlibrary/assets/nipp-ssp-water-2010.pdf>.

was necessary to determine whether or not their occurrences and cumulative consequences pose a credible threat to the security of the nation.

The U.S. Department of Homeland Security identifies the National Critical Infrastructure Sectors as critical to our nation's security. Therefore, these sectors were chosen to serve as the subject for this evaluation. The next chapter provides an overview of the Critical Infrastructure Sectors and validates the important roles they play in ensuring the security of the nation.

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### III. PRIMER ON CRITICAL INFRASTRUCTURE SECTORS

If the workers took a notion they could stop all speeding trains; every ship upon the ocean they can tie with mighty chains. Every wheel in the creation, every mine and every mill; fleets and armies of the nation, will at their command stand still.

—Joe Hill

#### A. INTRODUCTION

The United States Department of Homeland Security identifies 16 critical infrastructure sectors

whose assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.<sup>68</sup>

The *NIPP 2013: Partnering for Critical Infrastructure Security and Resilience* identifies four Critical Infrastructure Sectors—Communications, Energy, Transportation Systems, and Water and Wastewater Systems—that provide critical lifeline functions for all sectors.<sup>69</sup> Each of the national critical infrastructure sectors depends on one or more of the lifeline sectors.<sup>70</sup> This chapter presents an overview of 12 of the critical infrastructure sectors and a detailed profile of the lifeline sectors and their level of criticality to the security of the nation.

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<sup>68</sup> “What Is Critical Infrastructure?,” U.S. Department of Homeland Security, accessed December 29, 2015, <http://www.dhs.gov/what-critical-infrastructure>.

<sup>69</sup> “NIPP 2013: Partnering for Critical Infrastructure Security and Resilience,” U.S. Department of Homeland Security, 17, accessed January 30, 2016, <https://www.dhs.gov/sites/default/files/publications/National-Infrastructure-Protection-Plan-2013-508.pdf>.

<sup>70</sup> “Critical Infrastructure Security and Resilience National Research and Development Plan Final Report and Recommendations,” National Infrastructure Advisory Council, November 14, 2014, 18, <http://www.dhs.gov/sites/default/files/publications/NIAC-CISR-RD-Plan-Report-Final-508.pdf>.

## B. NATIONAL CRITICAL INFRASTRUCTURE SECTORS

Presidential Policy Directive: Critical Infrastructure Security and Resilience (PPD/21) establishes 16 critical infrastructure sectors.<sup>71</sup> Figure 1 identifies these sectors.

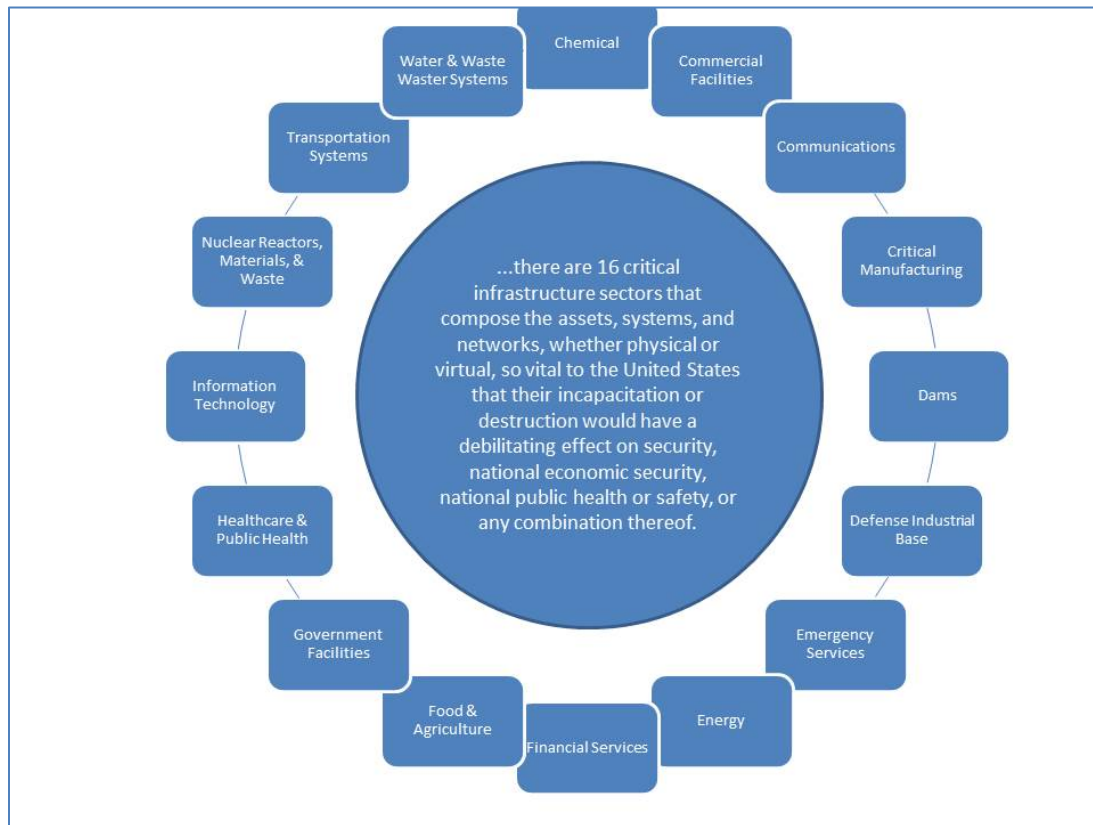


Figure 1. Critical Infrastructure Sectors<sup>72</sup>

<sup>71</sup> "Presidential Policy Directive–Critical Infrastructure Security and Resilience, Presidential Policy Directive/PPD-21," The White House, Office of the Press Secretary, accessed January 6, 2016, <https://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil>.

<sup>72</sup> Adapted from "What Is Critical Infrastructure?," U.S. Department of Homeland Security, accessed January 20, 2016, <https://www.dhs.gov/what-critical-infrastructure>.

## **1. Chemical Sector**

The Chemical Sector produces “more than 70,000 diverse products that are essential to modern life.”<sup>73</sup> The Communications, Energy, Information Technology, Transportation Systems and Water and Wastewater Systems sectors share interdependencies with the Chemical Sector.<sup>74</sup> This “makes the uninterrupted production and transportation of chemicals essential for national and economic security.”<sup>75</sup> According to the *2010 Chemical Sector-Specific Plan*, 96 percent of goods manufactured in the United States in 2013 depended on products supplied by the chemical sector.<sup>76</sup>

## **2. Commercial Facilities Sector**

The Commercial Facilities Sector includes the real estate industry; and facilities for entertainment media, gaming, lodging, outdoor events, public assembly, retail enterprises, and sports events. “The majority of facilities have open public access and house the business activities and commercial transactions that dominate the U.S. economy.”<sup>77</sup> The sector is dependent on the Communications, Emergency Services, Energy, Food and Agriculture, Financial Services, Government Facilities, Healthcare and Public Health, Transportation Systems and Water and Waste Water Systems Sectors.<sup>78</sup>

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<sup>73</sup> “2015 Chemical Sector-Specific Plan: An Annex to the NIPP, 2013,” U.S. Department of Homeland Security, 2, accessed November 15, 2015, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-chemical-2015-508.pdf>.

<sup>74</sup> “2015 Chemical Sector-Specific Plan,” U.S. Department of Homeland Security, 3.

<sup>75</sup> *Ibid.*, 2.

<sup>76</sup> *Ibid.*

<sup>77</sup> “Commercial Facilities Sector-Specific Plan: An Annex to the NIPP, 2013,” U.S. Department of Homeland Security, 2015 2, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-commercial-facilities-2015-508.pdf>.

<sup>78</sup> *Ibid.*, 3.

### **3. Critical Manufacturing Sector**

The Critical Manufacturing Sector produces primary metals;<sup>79</sup> electrical equipment, appliances, and components; transportation equipment; aviation and aerospace products and parts; and railroad rolling stock.<sup>80</sup> The sector “includes the manufacturing industries that are the most crucial for the continuity of other critical sectors and have significant national economic implications.”<sup>81</sup> This statement is supported by the American Association of Manufacturers, which reported \$2,090.7 billion was made from manufacturing production in 2014.<sup>82</sup> The sector shares interdependencies with the Chemical, Communications, Energy, Information Technology, Transportation Systems and Water and Wastewater Systems Sectors.<sup>83</sup>

### **4. Dams Sector**

The Dams Sector provides critical water retention and water control services such as irrigation, hydroelectric power generation; water and wastewater management; flood control; and river transportation. Its facilities include dams, hydropower plants, navigation locks, levees, dikes, hurricane barriers, and industrial waste impoundments.<sup>84</sup> Dams Sector facilities are reported to “irrigate at least 10 percent of U.S. cropland, help protect more than 43 percent of the U.S. population from flooding, and generate about 60

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<sup>79</sup> The Hudson Institute of Minerology defines primary metal as “Metal recovered as a principal or byproduct material from the processing of ores; includes metal recovered from ore processing wastes such as tailings, and downstream processing wastes such as slags and residues from the smelting and refining of the metal. Excludes metal recovered from scrap or its processing wastes (secondary metal),” accessed February 10, 2016, [http://www.mindat.org/glossary/primary\\_metal](http://www.mindat.org/glossary/primary_metal).

<sup>80</sup> *Merriam-Webster Online Dictionary*, s.v. “railroad rolling stock”: “the wheeled vehicles owned and used by a railroad or motor carrier,” accessed January 6, 2016, <http://www.merriam-webster.com/dictionary/rolling%20stock>.

<sup>81</sup> “2015 Critical Manufacturing Sector-Specific Plan, An Annex to the NIPP 2013,” U.S. Department of Homeland Security, iv, accessed May 21, 2016, <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-critical-manufacturing-2015-508.pdf>.

<sup>82</sup> “United States Manufacturing Facts,” National Association of Manufacturers, last modified December 2015, <http://www.nam.org/Data-and-Reports/State-Manufacturing-Data/State-Manufacturing-Data/December-2015/Manufacturing-Facts--United-States.pdf>.

<sup>83</sup> “2015 Critical Manufacturing Sector-Specific Plan, An Annex to the NIPP 2013,” U.S. Department of Homeland Security, 3.

<sup>84</sup> “2015 Dams Sector-Specific Plan: An Annex to the NIPP, 2013,” U.S. Department of Homeland Security, v, accessed December 20, 2015, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-dams-2015-508.pdf>.

percent of electricity in the Pacific Northwest.”<sup>85</sup> The sector shares interdependencies with the Communications; Energy; Food and Agriculture; Transportation Systems; and Water and Wastewater Systems Sectors.<sup>86</sup>

## **5. Defense Industrial Base Sector**

The Defense Industrial Base Sector includes activities for “design, production, delivery, and maintenance of military weapons systems, subsystems, and components or parts, to meet U.S. military requirements.”<sup>87</sup> Interdependencies for this sector are not specifically addressed in the *2010 Defense Industrial Base Sector-Specific Plan* because the defense industrial base “partnership has not addressed commercial infrastructure interdependencies in a systematic way.”<sup>88</sup> However, the plan does identify the sector’s intent to work with other sectors “to better understand and develop solutions to mitigate risks associated with critical dependencies/interdependencies and supply chain linkages.”<sup>89</sup> The plan states this undertaking will begin with the “Oil and Natural Gas, Electricity, Water, IT, Communications, and Transportation Systems Sectors and Subsectors.”<sup>90</sup> (Since the publication of this sector’s specific plan, the sectors and subsectors of the Oil and Natural Gas, Electricity Sectors; and Water Sector have been combined under the Energy Sector and Water and Wastewater Systems Sector, respectively.)

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<sup>85</sup> Ibid.

<sup>86</sup> “2015 Dams Sector-Specific Plan: An Annex to the NIPP, 2013,” U.S. Department of Homeland Security, 3.

<sup>87</sup> “2010 Defense Industrial Base Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 11, accessed December 20, 2015, <http://www.dhs.gov/xlibrary/assets/nipp-ssp-defense-industrial-base-2010.pdf>.

<sup>88</sup> Ibid., 12.

<sup>89</sup> Ibid., 25.

<sup>90</sup> Ibid.

## **6. Emergency Services Sector**

The Emergency Services Sector primarily focuses on prevention, preparedness, response, and recovery.<sup>91</sup> This sector “also serves as the primary protector for the other 15 critical infrastructure sectors.”<sup>92</sup> It is comprised of personnel from the public and private sectors, non-governmental organizations, faith-based and volunteer organizations involved in public safety functions such as the fire service, law enforcement, public works, health and social services; emergency medical services, and emergency management disciplines.<sup>93</sup> This sector is of critical importance to the nation because the “incapacitation of any of the assets, networks, or systems in this sector, whether physical or virtual, could cause significant harm or loss of life, public health issues, and/or long-term economic loss.”<sup>94</sup> The Communications; Energy; Healthcare and Public Health; Information Technology; Transportation Systems and Water and Wastewater Systems sectors are identified as critical interdependencies for the Emergency Services Sector.<sup>95</sup>

## **7. Financial Services Sector**

The Financial Services Sector is organized and regulated based on the services and products it provides. These include: “(1) deposit, consumer credit, and payment systems products; (2) credit and liquidity products; (3) investment products; and (4) risk transfer products.”<sup>96</sup> The organizations that make up the Financial Services Sector “form the backbone of the Nation’s financial system and are a vital component of the global economy.”<sup>97</sup> Most of these services are dependent on information and communication

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<sup>91</sup> “Emergency Services Sector,” U.S. Department of Homeland Security, accessed December 20, 2015, <http://www.dhs.gov/emergency-services-sector>.

<sup>92</sup> Ibid.

<sup>93</sup> “Emergency Services Sector-Specific Plan: An Annex to the NIPP, 2013,” U.S. Department of Homeland Security, 2015 3, accessed December 20, 2015, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-emergency-services-2015-508.pdf>.

<sup>94</sup> Ibid.

<sup>95</sup> Ibid., 4.

<sup>96</sup> “Financial Services Sector-Specific Plan 2015,” U.S. Department of Homeland Security, 6, accessed May 21, 2016, <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-financial-services-2015-508.pdf>.

<sup>97</sup> Ibid., 8.

technology platforms.<sup>98</sup> In addition to Information Technology and Communications, this sector also shares interdependencies with the Communications, Energy, and the Transportation Systems Sectors.<sup>99</sup>

## **8. Food and Agriculture Sector**

The Food and Agriculture (FA) Sector is concerned with the production, processing, and delivery of agricultural and food commodities to the nation and the worldwide market. As defined in the *Food and Agriculture Sector-Specific Plan, 2015*, “agriculture comprises establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.”<sup>100</sup> The FA sector “accounts for roughly one-fifth of the Nation’s economic activity. In 2012, total agricultural product sales amounted to \$400 billion, with crops and livestock each accounting for roughly half the FA Sector.”<sup>101</sup> The sector has “roughly 2.1 million farms, encompassing 915 million acres of land...[and] produce \$212 billion in crop production. The top five cash-producing industries are cattle, poultry and eggs, corn, soybeans, and milk.”<sup>102</sup> The Chemical, Commercial Facilities, Communications, Energy, Financial Services, Healthcare and Public Health, Information Technology, Transportation Systems, Water and Wastewater Systems Sectors share interdependencies with this sector.<sup>103</sup>

## **9. Government Facilities Sector**

The Government Facilities Sector includes facilities that allow public access for business and recreational purposes as well as those that are closed to the public because

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<sup>98</sup> Ibid.

<sup>99</sup> “2010 Banking and Finance Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 24, accessed December 26, 2015, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-banking-and-finance-2010.pdf>.

<sup>100</sup> “Food and Agriculture Sector-Specific Plan, 2015,” U.S. Department of Homeland Security, 4, accessed May 21, 2016, <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-food-ag-2015-508.pdf>.

<sup>101</sup> Ibid., 2.

<sup>102</sup> Ibid.

<sup>103</sup> Ibid., 21–22.

of security reasons. These facilities may be publicly or privately owned.<sup>104</sup> This sector does not have a sector-specific plan. Instead, there are “snapshots” published for two of its subsectors. The Education Facilities Subsector “covers pre-kindergarten through 12th grade schools, institutions of higher education, and business and trade schools” and the National Monuments and Icons Subsector with assets that are included in the “National Register of Historic Places or the List of National Historic Landmarks.”<sup>105</sup> Interdependencies with the Commercial Facilities, Healthcare and Public Health, Nuclear Reactor, Materials and Waste, and Transportation Systems Sectors are identified for the Education Facilities Subsector.<sup>106</sup> No interdependencies are identified for the National Monuments and Icons Subsector.

## **10. Healthcare and Public Health Sector**

The Healthcare and Public Health Sector includes the facilities and personnel that provide healthcare, pharmaceuticals, medical supplies and equipment; and veterinary and mortuary services.<sup>107</sup> This sector has “approximately 13 million healthcare personnel from many professions.”<sup>108</sup> The *2010 Healthcare and Public Health Sector-Specific Plan* identifies this sector as having “a crucial role in preparedness and response for all hazards. The sector is responsible for mitigating the physical and psychological health impacts associated with incidents.”<sup>109</sup> The identified interdependencies for this sector are the Chemical, Communications, Emergency Services, Energy, Food and Agriculture,

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<sup>104</sup> A sector-specific annex to the National Infrastructure Protection Plan for the Government Facilities Sector was not available for review. Instead, the presented information is excerpted from the U.S. Department of Homeland Security, “Government Facilities Sector,” accessed December 20, 2015, <http://www.dhs.gov/government-facilities-sector>.

<sup>105</sup> Ibid.

<sup>106</sup> “Education Facilities Subsector Snapshot,” Interdependencies for the Education Facilities Subsector are excerpted from the U.S. Department of Homeland Security, accessed December 20, 2015, <http://www.dhs.gov/xlibrary/assets/nppd/nppd-ip-education-facilities-snapshot-2011.pdf>.

<sup>107</sup> “2010 Healthcare and Public Health Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 9–10, accessed December 29, 2015, <http://www.dhs.gov/xlibrary/assets/nipp-ssp-healthcare-and-public-health-2010.pdf>.

<sup>108</sup> Ibid., 10.

<sup>109</sup> Ibid.



Information Technology, Transportation Systems, and Water and Wastewater Systems Sectors.<sup>110</sup>

## **11. Information Technology Sector**

The Information Technology Sector is “a functions-based sector that comprises not only physical assets but also virtual systems and networks that enable key capabilities and services in both the public and private sectors.”<sup>111</sup> Unlike the other critical infrastructure sectors it is not “composed of finite and easily identifiable physical assets.”<sup>112</sup> The sector is further defined by its lack of geographic or political boundaries. No specific interdependencies are identified in this sector’s specific plan. However, the following statement related to interdependencies was found on the Information Technology Sector webpage:

The Information Technology Sector is central to the nation’s security, economy, and public health and safety. Businesses, governments, academia, and private citizens are increasingly dependent upon Information Technology Sector functions.<sup>113</sup>

## **12. Nuclear Reactors, Materials and Waste Sector**

The Nuclear Reactors, Materials and Waste Sector is composed of

Commercial nuclear power plants; non-power reactors used for research, training, and radioisotope production; fuel-cycle facilities; and nuclear and radioactive materials used in medical, industrial, and academic settings. Additional assets include power reactors and other nuclear facilities that are under construction, and those that are being decommissioned and

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<sup>110</sup> “2010 Healthcare and Public Health Sector-Specific Plan,” U.S. Department of Homeland Security, 12.

<sup>111</sup> *Ibid.*, 1.

<sup>112</sup> “2010 Information Technology Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” 1, U.S. Department of Homeland Security, accessed December 29, 2015, <http://www.dhs.gov/sites/default/files/publications/IT%20Sector%20Specific%20Plan%202010.pdf>.

<sup>113</sup> “Information Technology Sector,” U.S. Department of Homeland Security, accessed December 29, 2015, <http://www.dhs.gov/information-technology-sector>.

dismantled. The sector also includes the transportation, storage, and disposal of nuclear materials, and radioactive waste.<sup>114</sup>

These rely on physical assets, virtual systems, and networks for continued operations.<sup>115</sup> The sector primarily shares interdependencies with the Chemical, Communications, Critical Manufacturing, Emergency Services, Energy, Healthcare and Public Health, Information Technology, Transportation Systems, and Water and Wastewater Sectors.<sup>116</sup>

### **C. LIFELINE SECTORS**

A Lifeline Sector is defined as “A sector that provides indispensable services that enable the continuous operation of critical business and government functions, and would risk human health and safety or national and economic security if compromised or not promptly restored.”<sup>117</sup> Figure 2 demonstrates the interdependencies between the lifeline sectors (in red) and the other critical infrastructure sectors. Lifeline sectors have the following commonalities.

- Provides essential products and services that underpin the continued operation of nearly every business sector, community, and government agency.
- Typically delivers products and services that are ubiquitous in normal circumstances but can create life-threatening conditions if they are unavailable for long or even short periods of time.
- Encompasses complex physical and cyber networks that are highly interconnected within their sector, between sectors, and within and between adjacent regions.

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<sup>114</sup> “2015 Nuclear Reactors, Materials and Waste Sector-Specific Plan: An Annex to the NIPP 2013,” U.S. Department of Homeland Security, 2, accessed May 21, 2016, <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-nuclear-2015-508.pdf>.

<sup>115</sup> Ibid., 9–12.

<sup>116</sup> Ibid., 11–12.

<sup>117</sup> “Strengthening Regional Resilience, Final Report and Recommendations,” National Infrastructure Advisory Council, November 21, 2013, 14, <http://www.dhs.gov/sites/default/files/publications/niac-regional-resilience-final-report-11-21-13-508.pdf>.

- Its disruption or destruction can cause failures that cascade across dependent infrastructures and regions, producing a multiplier effect of impacts.<sup>118</sup>

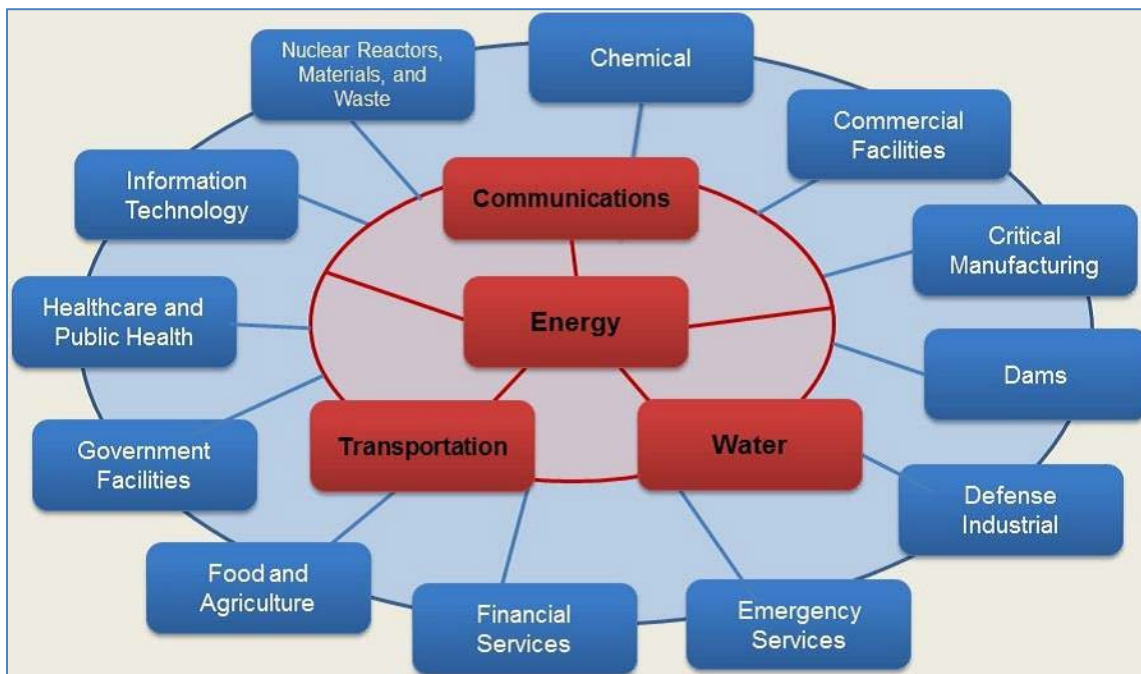


Figure 2. Critical Infrastructure Sectors Interdependencies<sup>119</sup>

## 1. Communications Sector Profile

The Communications Sector is identified by the U.S. Department of Homeland Security as “an integral component of the U.S. economy, underlying the operations of all businesses, public safety organizations, and government.”<sup>120</sup> According to the *2010 Communications Sector-Specific Plan*, “the Nation’s communications infrastructure is a complex system of systems that incorporates multiple technologies and services with

<sup>118</sup> “Strengthening Regional Resilience, Final Report and Recommendations,” National Infrastructure Advisory Council, 14.

<sup>119</sup> Source: “2015 Energy Sector-Specific Plan,” U.S. Department of Homeland Security, 19, accessed January 20, 2016, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-energy-2015-508.pdf>.

<sup>120</sup> “Communications Sector,” U.S. Department of Homeland Security, accessed December 20, 2015, [www.dhs.gov/communications-sector](http://www.dhs.gov/communications-sector).

diverse ownership.”<sup>121</sup> The sector is comprised of “wireline [telegraph or telephone line],<sup>122</sup> wireless, satellite, cable, and broadcasting capabilities, and includes the transport networks that support the Internet and other key information systems.”<sup>123</sup> A major challenge facing this sector is to convince users of the importance of redundant communications methods, especially for the emergency response community.<sup>124</sup>

The use of the physical and virtual assets of the Communications Sector underlies “virtually every element of modern life.”<sup>125</sup> “Presidential Policy Directive 21 identifies the Communications Sector as critical because it provides an ‘enabling function’ across all critical infrastructure sectors.”<sup>126</sup> This determination as an “enabling function” qualifies the Communications Sector as a lifeline sector.

The Federal Communications Commission has identified electric power as the “dominant dependency for the Communications Sector.”<sup>127</sup> This sector depends on the Energy Sector for the “power to run cellular towers, central offices, and other critical communications facilities.”<sup>128</sup> As a contingency, backup generators are used to provide power for communications facilities when the primary power source fails. The operation of generators is reliant on other products the Energy Sector produces such as gasoline, diesel, propane, and natural gas. Maintaining a consistent supply chain of fuels also creates a dependency on the Transportation Systems Sector. Additionally, the Communications Sector “co-locates much of its networking equipment (routers, fiber-optic cable, etc.) along existing transportation routes (rail lines, highway tunnels, and

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<sup>121</sup> “2010 Communications Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 2, accessed December 20, 2015, <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-communications-2010-508.pdf>.

<sup>122</sup> *Oxford Dictionary*, s.v. “Wireline,” accessed February 11, 2016, [http://www.oxforddictionaries.com/us/definition/american\\_english/wireline](http://www.oxforddictionaries.com/us/definition/american_english/wireline).

<sup>123</sup> “2010 Communications Sector-Specific Plan,” U.S. Department of Homeland Security, 2.

<sup>124</sup> *Ibid.*, 13.

<sup>125</sup> *Ibid.*, 5.

<sup>126</sup> “Communications Sector,” U.S. Department of Homeland Security.

<sup>127</sup> “Tech Topic 19: Communications Interdependencies,” Federal Communications Commission, Public Safety and Homeland Security Bureau, accessed February 4, 2016, <https://transition.fcc.gov/pshs/techtopics/techtopics19.html>.

<sup>128</sup> U.S. Department of Homeland Security, “Communications Sector.”

bridges).”<sup>129</sup> The Water and Wastewater Systems Sector is critical to the Communications Sector because “the environmental control systems for communications facilities rely on freshwater for air conditioning and other environmental services.”<sup>130</sup> Additionally, the treatment of wastewater from chillers or coolers is “essential for most large scale communications facilities.”<sup>131</sup>

## **2. Energy Sector Profile**

The “U.S. energy infrastructure fuels the economy of the 21st century. Without a stable energy supply, health and welfare are threatened, and the U.S. economy cannot function.”<sup>132</sup> The Energy Sector is identified in Presidential Policy Directive 21 “as uniquely critical” because it provides an “enabling function” across all critical infrastructure sectors.<sup>133</sup> This designation as an “enabling function” qualifies the Energy Sector as a lifeline sector. The sector is comprised of primary and secondary energy sources.

Primary energy includes petroleum, natural gas, coal, nuclear energy, and renewable energy. Electricity is a secondary energy source that is generated using these primary forms of energy. For example, coal is a primary energy source that is burned by electric power plants to generate electricity, which is a secondary source of energy.<sup>134</sup>

In addition to coal, natural gas, nuclear sources, and renewable energy resources (hydro, wind, biomass, geothermal, and solar power) are also used in the generation of

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<sup>129</sup> “2010 Transportation Systems Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 16, accessed December 26, 2015, <http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation-systems-2010.pdf>.

<sup>130</sup> “Tech Topic 19: Communications Interdependencies,” Federal Communications Commission, Public Safety and Homeland Security Bureau.

<sup>131</sup> “Tech Topic 19: Communications Interdependencies,” Federal Communications Commission, Public Safety and Homeland Security Bureau.

<sup>132</sup> “Energy Sector,” U.S. Department of Homeland Security, accessed January 6, 2016, <http://www.dhs.gov/energy-sector>.

<sup>133</sup> “Presidential Policy Directive—Critical Infrastructure Security and Resilience, Presidential Policy Directive/PPD-21,” The White House, Office of the Press Secretary,

<sup>134</sup> “What Are the Major Sources and Users of Energy in the United States?,” U.S. Energy Information Administration, accessed February 12, 2016, [http://www.eia.gov/energy\\_in\\_brief/article/major\\_energy\\_sources\\_and\\_users.cfm](http://www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm).

electricity.<sup>135</sup> Electric power is pervasive in the United States and is used for lighting, heating, cooling, refrigeration, and to power appliances, computers, machinery, medical devices and public transportation systems. The U.S. Energy Information Administration reports that

the largest single use of electricity in the U.S. residential sector on an annual basis is for air conditioning (cooling), followed by space heating, lighting, water heating, refrigeration, and televisions and related electronic equipment. About 40 percent of annual electricity use is by clothes washers and dryers, computers and related equipment, dishwashers, and small appliances and electrical equipment.<sup>136</sup>

Meanwhile, in the commercial sector:

Lighting is the largest use of electricity in the U.S. commercial sector, which includes retail, office, education, institutional, public, and government buildings, and outdoor and public street lighting. The other major commercial uses of electricity are for ventilation, cooling, refrigeration, powering computers and other office equipment, and space and water heating. There are many other uses of electricity in this sector that include powering medical, security, and fire suppression equipment; powering elevators and escalators; and running cooking and laundry equipment.<sup>137</sup>

Crude oil is processed to produce petroleum products such as gasoline, diesel fuel, heating oil, jet fuel, lubricating oils, and asphalt.<sup>138</sup> In 2014, an average of 13,452 gallons of petroleum products were consumed per day by the transportation industry.<sup>139</sup> Natural gas is used in the production of a myriad of products including steel, glass, paper, clothing, paints, fertilizer, plastics, antifreeze, medicines, and explosives. It is also used by 50 percent of American homes for heating, cooking, and clothes dryers. The top

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<sup>135</sup> Information compiled with data obtained from “What Is the Role of Coal in the United States?,” U.S. Energy Information Administration, accessed February 12, 2016, [http://www.eia.gov/energy\\_in\\_brief/article/role\\_coal\\_us.cfm](http://www.eia.gov/energy_in_brief/article/role_coal_us.cfm).

<sup>136</sup> “Electricity Explained: Use of Electricity,” U.S. Energy Information Administration, accessed February 12, 2016, [http://www.eia.gov/energyexplained/index.cfm?page=electricity\\_use](http://www.eia.gov/energyexplained/index.cfm?page=electricity_use).

<sup>137</sup> “Electricity Explained: Use of Electricity,” U.S. Energy Information Administration,

<sup>138</sup> “How Much Gasoline Does the United States Consume?,” U.S. Energy Information Administration, accessed February 12, 2016, <http://www.eia.gov/tools/faqs/faq.cfm?id=23&t=10>.

<sup>139</sup> Information compiled with data obtained from “Table 3.7c Petroleum Consumption: Transportation and Electric Power Sectors,” U.S. Energy Information Administration, accessed February 12, 2016, [http://www.eia.gov/totalenergy/data/monthly/pdf/sec3\\_21.pdf](http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_21.pdf).

consumers of natural gas, in order of usage for 2014 are: 1) electric power generation; 2) industrial use; 3) residential consumers; 4) commercial enterprises; and 5) oil and natural gas industry.<sup>140</sup>

The Energy Sector is “reliant on commercial communications facilities for transferring information.”<sup>141</sup> It relies heavily on the Transportation Systems Sector to maintain an adequate supply of source materials for electric power generation.<sup>142</sup> It also depends on pipeline systems “to distribute products across the Nation.”<sup>143</sup> The U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis also reports that “82 percent of electric generation plants surveyed are dependent upon water.”<sup>144</sup>

### **3. Transportation Systems Sector Profile**

The Transportation Systems Sector is comprised of “diverse and interconnected networks of fixed and mobile assets that provide essential services for the Nation’s livelihood and economic prosperity.”<sup>145</sup> These systems “transport people, food, water, medicines, fuel, and other commodities vital to the public health, safety, security, and economic well-being of our Nation.”<sup>146</sup> The continuation of services for this sector relies on “physical, human, and cyber components.”<sup>147</sup> The Transportation Systems Sector is

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<sup>140</sup> “Natural Gas Explained: Use of Natural Gas,” U.S. Energy Information Administration, accessed February 12, 2016, [http://www.eia.gov/energyexplained/index.cfm?page=natural\\_gas\\_use](http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_use).

<sup>141</sup> “Communications Sector,” U.S. Department of Homeland Security.

<sup>142</sup> “Energy Sector,” U.S. Department of Homeland Security.

<sup>143</sup> Ibid.

<sup>144</sup> “Sector Resilience Report: Water and Wastewater Systems,” U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, July 22, 2014, 2, [https://www.massport.com/media/266269/Report\\_Sector-Resilience-Report-Water-and-Wastewater.pdf](https://www.massport.com/media/266269/Report_Sector-Resilience-Report-Water-and-Wastewater.pdf).

<sup>145</sup> “2015 Transportation Systems Sector-Specific Plan,” U.S. Department of Homeland Security, 1, accessed May 22, 2016, <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-transportation-systems-2015-508.pdf>.

<sup>146</sup> Ibid.

<sup>147</sup> Ibid.

identified as being critical to all of the other critical infrastructure sectors.<sup>148</sup> This criticality is the underlying factor for its designation as a lifeline sector.<sup>149</sup>

There are seven subsectors of transportation modes included in this sector. According to the U.S. Department of Homeland Security:

- (1) The aviation subsector includes not only aircraft but also air traffic control systems, airports, heliports, and landing strips.
- (2) The highway infrastructure and motor carrier subsector includes approximately 4 million miles of roadways, 600,000 bridges, and 350 tunnels.
- (3) The maritime transportation system is comprised of 95,000 miles of coastline, 25,000 miles of waterways, 361 ports, and “intermodal landside connections, which allow the various modes of transportation to move people and goods to, from, and on the water.”<sup>150</sup>
- (4) The mass transit and passenger rail is comprised of buses, subways, trolleys, streetcars, cable cars, and long-distance rail such as Amtrak.
- (5) The pipeline systems carry approximately 65 percent of hazardous liquids; chemicals; and nearly all of the natural gas in the United States. The pipeline system traverses more than 2.5 million miles across the Nation.
- (6) The freight rail consists of more than 138,000 miles of active railroad, 1.3 million freight cars, and approximately 20,000 locomotives. Additionally, 30,000 miles of track are designated “as critical to mobilization and resupply of U.S. forces.”<sup>151</sup>
- (7) The postal and shipping subsector handles 720 million letters and packages each day.<sup>152</sup>

The Transportation Systems Sector is reliant on the Energy Sector’s fuel products to operate varying modes of transportation; power for heating, cooling, and lighting of its

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<sup>148</sup> Ibid., 2.

<sup>149</sup> “NIPP 2013: Partnering for Critical Infrastructure Security and Resilience,” U.S. Department of Homeland Security, 17.

<sup>150</sup> “Transportation Systems Sector,” U.S. Department of Homeland Security, accessed May 22, 2016, <http://www.dhs.gov/transportation-systems-sector>.

<sup>151</sup> Ibid.

<sup>152</sup> Ibid.



facilities; and for the uninterrupted service of digital transportation network systems. The Communications Sector is also critical for the operations of these network systems.<sup>153</sup> The Water and Wastewater Systems Sector provides resources for “cleaning of equipment and de-icing airplanes (aviation); water for cooling of equipment (mass transit, highway, and freight rail); and common rights of way (pipeline).”<sup>154</sup>

#### **4. Water and Wastewater Systems Profile**

The Water and Wastewater Systems Sector is comprised of “approximately 153,000 public drinking water systems and more than 16,000 publicly owned wastewater treatment systems.”<sup>155</sup> These systems provide drinking water to 84 percent of the nation’s population, and 75 percent of the population’s sewage is treated by these wastewater systems.<sup>156</sup> The sector’s infrastructure includes physical facilities, information technology, and communications. This sector is critical to the security of the nation because:

Safe drinking water is a prerequisite for protecting public health and all human activity, and properly treated wastewater is vital for preventing disease and protecting the environment. Ensuring continuity of drinking water and wastewater treatment and service is essential to modern life and the Nation’s economy.<sup>157</sup>

The essential services provided by the Water and Wastewater Systems Sector are the underlying factors for its designation as a lifeline sector.<sup>158</sup> In a study conducted by the U.S. Department of Homeland Security, it was reported that 75 percent of the critical

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<sup>153</sup> “2010 Transportation Systems Sector-Specific Plan,” U.S. Department of Homeland Security, 16.

<sup>154</sup> James K. Sullivan, *Water Sector Interdependencies Summary Report 2011*. (Alexandria, VA: Water Environment Federation, 2011), 15, accessed February 12, 2016, [http://www.wef.org/uploadedFiles/Access\\_Water\\_Knowledge/Water\\_Security\\_and\\_Emergency\\_Response/Final\\_WEF\\_Summary\\_WSI.pdf](http://www.wef.org/uploadedFiles/Access_Water_Knowledge/Water_Security_and_Emergency_Response/Final_WEF_Summary_WSI.pdf).

<sup>155</sup> “Water and Wastewater Systems Sector,” U.S. Department of Homeland Security, accessed May 22, 2016, <http://www.dhs.gov/water-and-wastewater-systems-sector>.

<sup>156</sup> *Ibid.*

<sup>157</sup> “2015 Water and Wastewater Systems Sector-Specific Plan,” U.S. Department of Homeland Security, 1, accessed May 22, 2016, <http://www.dhs.gov/xlibrary/assets/nipp-ssp-water-2010.pdf>.

<sup>158</sup> “NIPP 2013: Partnering for Critical Infrastructure Security and Resilience,” U.S. Department of Homeland Security, 17.

infrastructure sectors receiving assessments between 2011 and 2014 depended on water and 68 percent depended on wastewater treatment services for continued operations.<sup>159</sup>

This sector also provides the primary resource for the generation of hydroelectric and thermoelectric power. The U.S. Department of Homeland Security Office of Cyber and Infrastructure Analysis reports that 60 percent of Oregon's and Washington's energy comes from hydroelectric generation. Thermoelectric generation accounts for 64 percent of the electricity produced in Arizona, New Mexico, Nevada, south and central California; and for 71.2 percent in Montana, Utah, Idaho, Colorado, and Wyoming.<sup>160</sup>

The Water and Wastewater Sector is dependent on the Transportation Systems Sector for deliveries of chemicals for the treatment of drinking water and wastewater products.<sup>161</sup> The Sector relies on the Energy Sector for power to run its facilities and on the Communications Sector for the operation of cyber-physical systems such as smart water meters.

#### **D. CONCLUSION**

This review of the critical infrastructure sectors identifies their functions; confirms their importance to the security of the Nation; and identifies critical interdependencies. Four of these—Communications, Energy, Transportation Systems, and Water and Wastewater Systems—are also identified by the U.S. Department of Homeland Security as lifeline sectors.<sup>162</sup> These lifeline sectors were chosen as subjects for risk assessments to determine whether or not slow-onset disasters pose a threat to their security and ultimately that of the Nation. My decision was based on the identified interdependency between these sectors; the dire consequences a failure of one or more

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<sup>159</sup> "Sector Resilience Report: Water and Wastewater Systems," U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 1.

<sup>160</sup> Molly Hellmuth et al., *Assessment of Climate Change Risks to Energy Reliability in the WECC Region* (Washington, DC: ICF International, 2014), 2, <https://www.wecc.biz/Reliability/Assessment-of-Climate-Change-Risks-to-Reliability-ICF-Dec-2014.pdf>.

<sup>161</sup> "2015 Water and Wastewater Systems Sector-Specific Plan," U.S. Department of Homeland Security, 35.

<sup>162</sup> "NIPP 2013: Partnering for Critical Infrastructure Security and Resilience," U.S. Department of Homeland Security, 17.

pose to all other sectors; and their established importance to national security. The results of these assessments are presented in the following chapter.

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## **IV. RISK ASSESSMENT: SLOW-ONSET DISASTERS AND THE LIFELINE SECTORS**

When it comes to risk, let facts rule—not fears.

—David Ropeik

### **A. INTRODUCTION**

Risk assessments are performed to identify hazards, ascertain vulnerabilities, analyze impacts, and develop strategies for reducing the extent of damages that may be caused by these hazards. The subject of risk assessments generally includes hazards that are of a natural, technological, or health-based origin. However, the principles can be applied to any event that poses a threat to the physical, social, economic, or environmental stability of a community, network, or system.<sup>163</sup>

### **B. METHODOLOGY**

The risk assessments in this chapter are based on the process identified in Figure 3. For the purpose of these assessments, ocean acidification, melting Arctic ice, sea-level rise and drought are pre-identified as the hazards and each of the four lifeline sectors are considered the assets at risk. These assessments identify the level of risk each hazard poses to the lifeline sectors based on probability and impact (magnitude, geographic extent, and losses). Mitigation actions are not addressed in the assessments. Results are displayed using a standardized Risk Assessment Matrix.

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<sup>163</sup> “Risk Assessment,” U.S. Department of Homeland Security, accessed February 12, 2016, <http://www.ready.gov/risk-assessment>.

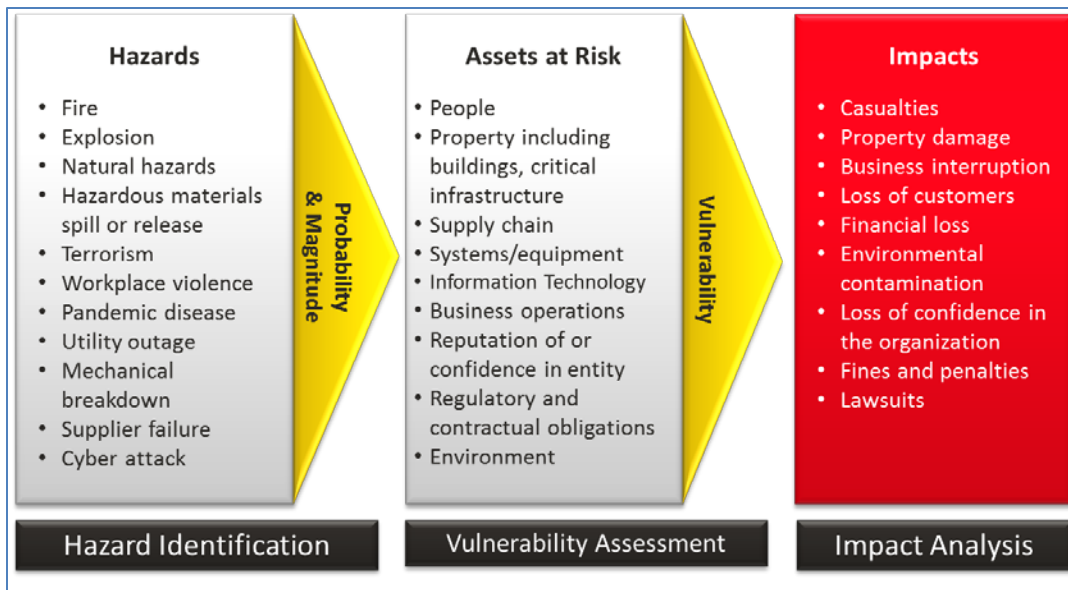


Figure 3. Risk Assessment Diagram<sup>164</sup>

### C. RISK ASSESSMENT MATRIX

The risk assessment matrices in Table 3 through Table 7 use the formula:

$$\text{Risk} = \text{Probability} \times \text{Impact}.$$

The values for probability and impact used in Table 3 through Table 7 are taken from the Emergency Management Institute's *IS-230.a Fundamentals of Emergency Management*:

#### Probability:

- Highly likely—near 100 percent probability in the next year.
- Likely—between 10 percent and 100 percent probability in the next year, or at least one chance in the next 10 years.
- Possible—between 1 percent and 10 percent probability in the next year, or at least one chance in the next 10 years.
- Unlikely—less than 1 percent probability in the next 100 years.

<sup>164</sup> Source: "Risk Assessment," [www.ready.gov](http://www.ready.gov).

**Impact:**

- Catastrophic—multiple deaths; shutdown of critical facilities for 1 month or more; more than 50 % of property severely damaged.
- Critical—injuries or illness resulting in permanent disability, shutdown of critical facilities for at least 2 weeks, 25% to 50% of property severely damaged.
- Limited—temporary injuries; shutdown of critical facilities for 1–2 weeks; 10% to 25% of property severely damaged.
- Negligible—injuries treatable with first aid; shutdown of critical facilities for 24 hours or less; less than 10% of property severely damaged.<sup>165</sup>

Table 3. Risk Assessment Matrix Template<sup>166</sup>

HAZARD	SECTOR	RISK		Probability	Impact
		VERY HIGH (16-20)	HIGH (11-15)		
			0	0	0
			0	0	0
			0	0	0
			0	0	0
<b>Probability :</b>					
4 = Highly Likely - near 100% probability in the next year					
3 = Likely - between 10% and 100% probability in the next year, or at least one chance in the next 10 years					
2 = Possible - between 1% and 10% probability in the next year, or at least one chance in the next 10 years					
1 = Unlikely - less than 1% probability in the next 100 years					
<b>Impact</b>					
4 = Catastrophic - multiple deaths; shutdown of critical facilities for 1 month or more; more than 50% of property severely damaged					
3 = Critical - injuries or illness resulting in permanent disability; shutdown of critical facilities for at least 2 weeks; 25% to 50% of property severely damage					
2 = Limited – temporary injuries; shutdown of critical facilities for 1-2 weeks; 10% to 25% of property severely damaged					
1 = Negligible – injuries treatable with first aid; shutdown of critical facilities for 24 hours or less; less than 10% of property severely damaged					

<sup>165</sup> U.S. Department of Homeland Security, Federal Emergency Management Agency, *IS-230a, Introduction to Hazard Mitigation*. (Emmitsburg, MD: Emergency Management Institute. 2010), 5.6.

<sup>166</sup> Adapted from the values for probability and impact presented in the Emergency Management Institute's *IS-230.a Fundamentals of Emergency Management*.

#### **D. RISK ASSESSMENT: OCEAN ACIDIFICATION**

Ocean acidification impacts the people that rely on the seafood industry for their livelihood, sustenance, and, in some cases, traditional way of life. While this slow-onset disaster poses a threat to the economy and the Food and Agriculture Sector (\$86.5 billion fishing industry); the environment (coral reefs, protected species, fish, and shellfish); social stability (native Alaskan populations' subsistence fishing); no evidence of direct threats were apparent to any the four lifeline sectors.

Research substantiates ocean acidification is found in varying degrees in the coastal waters along the U.S. seaboard. Therefore, this hazard is assigned a probability value of (4) Highly Likely. Since my research did not reveal any evidence that ocean acidification poses a direct threat to the lifeline sectors, it is assigned the value of (1) Negligible impact for each of these sectors. Based on these values, ocean acidification is found to pose a low risk to the Communications, Energy, Transportation Systems, and Water and Wastewater Systems sectors. These findings are summarized in Table 4.



Table 4. Ocean Acidification—Risk Assessment Matrix<sup>167</sup>

HAZARD	SECTOR	RISK		Probability	Impact
		VERY HIGH(16-20)	HIGH (11-15)		
Ocean Acidification	Communications	LOW	4	4	1
	Energy	LOW	4	4	1
	Transportation	LOW	4	4	1
	Water & Wastewater	LOW	4	4	1
<b>Probability :</b>					
4 = Highly Likely - near 100% probability in the next year					
3 = Likely - between 10% and 100% probability in the next year, or at least one chance in the next 10 years					
2 = Possible - between 1% and 10% probability in the next year, or at least one chance in the next 10 years					
1 = Unlikely - less than 1% probability in the next 100 years					
<b>Impact</b>					
4 = Catastrophic - multiple deaths; shutdown of critical facilities for 1 month or more; more than 50% of property severely damaged					
3 = Critical - injuries or illness resulting in permanent disability; shutdown of critical facilities for at least 2 weeks; 25% to 50% of property severely damage					
2 = Limited – temporary injuries; shutdown of critical facilities for 1-2 weeks; 10% to 25% of property severely damaged					
1 = Negligible – injuries treatable with first aid; shutdown of critical facilities for 24 hours or less; less than 10% of property severely damaged					

## E. RISK ASSESSMENT: MELTING ARCTIC ICE

Melting Arctic ice contributes to the loss of permafrost resulting in land subsidence.<sup>168</sup> This causes damages to permanent infrastructures such as buildings, pipelines, rail tracks, airstrips, and roads.<sup>169</sup> It creates hardships for the vulnerable population (100,000 people)<sup>170</sup> and, in some cases, threatens forced relocation of entire communities (31 communities).<sup>171</sup> Melting sea ice threatens the environment (protected

<sup>167</sup> Adapted from the Emergency Management Institute's *IS-230.a Fundamentals of Emergency Management*.

<sup>168</sup> *Oxford Dictionaries*, s.v. "subsidence": "the gradual caving in or sinking of an area of land," accessed February 14, 2016, [http://www.oxforddictionaries.com/us/definition/american\\_english/subsidence](http://www.oxforddictionaries.com/us/definition/american_english/subsidence).

<sup>169</sup> National Research Council of the National Academies, *Potential Impacts of Climate Change on U.S. Transportation*, Committee on Climate Change and U.S. Transportation, Transportation Research Board, Division of Earth and Life Sciences. (Washington, DC: Transportation Research Board), 192, accessed February 14, 2016, <http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf>.

<sup>170</sup> "Climate Change Impacts and Adaptation," United States Environmental Protection Agency.

<sup>171</sup> Robin Bronen, *Climate-Induced Displacement of Alaska Native Communities*, 9–18.

species, seals, walruses, plankton, and plants)<sup>172</sup> and the cultural stability of the Native Alaskan population (subsistence hunting and traditional way of life).<sup>173</sup> Studies have shown the melting ice fields contributes to changes in the North American jet stream (extreme snowfall, more intense hurricanes, heat waves and drought)<sup>174</sup> and has increased sea-level rise (40 percent in 35 years).<sup>175</sup>

The ice roads in Alaska are lifelines for the northern communities and the mining, oil and gas industries and can only be traversed when frozen. Melting permafrost and the resulting land subsidence has shortened the timeframe when these roads can be traveled while increasing maintenance costs for the transportation industry (extra \$10 million per year).<sup>176</sup> The Trans-Alaska Pipeline System has 800 miles of elevated pipeline that traverses permafrost areas and transports “approximately 15 percent of the Nation’s domestic oil production.”<sup>177</sup>

More than 80 percent of Alaska’s economy comes from energy production.<sup>178</sup> Impassable ice roads lead to shorter seasons for “land-based energy exploration.”<sup>179</sup> However, melting ice fields have also created new opportunities for the region. The Arctic Ocean is now more accessible for marine vessels to transport energy resources and

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<sup>172</sup> “Alaska: Climate Impacts in Alaska,” United States Environmental Protection Agency, accessed February 14, 2016, <https://www3.epa.gov/climatechange/impacts/alaska.html>.

<sup>173</sup> Ibid.

<sup>174</sup> Jeffrey P. Donnelly et al., “Climate Forcing of Unprecedented Intense Hurricane Activity in the Last 2000 Years,” 49–65.

<sup>175</sup> Jerry M. Melillo, *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*, 60.

<sup>176</sup> Henry G. Schwartz et al., “Transportation,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, eds. Jerry M. Melillo, Terese (T. C.) Richmond, and Gary W. Yohe, eds. (Washington, DC: U.S. Global Change Research Program, 2014), 132, <http://nca2014.globalchange.gov/report/sectors/transportation>.

<sup>177</sup> “Trans-Alaska Pipeline: North Slope to the Northernmost Ice-Free Port,” Explore Fairbanks Alaska, accessed February 14, 2016, <http://www.explorefairbanks.com/go/energy/trans-alaska-pipeline/27>.

<sup>178</sup> F. Stewart Chapin III et al., “Alaska,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, eds. Jerry M. Melillo, Terese (T. C.) Richmond, and Gary W. Yohe (Washington, DC: U.S. Global Change Research Program, 2014), 515, <http://nca2014.globalchange.gov/report/regions/alaska>.

<sup>179</sup> Ibid.

new areas have been uncovered where it is possible to extract “substantial deposits of oil and natural gas under the seafloor.”<sup>180</sup>

Research substantiates the fact that the Arctic ice fields are melting. Therefore, this hazard is assigned a probability value of (4) Highly Likely. While melting Arctic ice is found to pose a significant threat to the Transportation Systems and Energy Sectors in the Arctic region, this finding is somewhat offset by the discovery of newly accessible oil and natural gas fields and improved accessibility for transportation by marine vessels. Additionally, the risk to the nation’s Energy Sector is found to be minimal as this region produces only 15 percent of the domestic oil production. Therefore, this hazard is assigned the value of (2) Limited impact to the Energy Sector. Since no evidence was apparent of any direct threat posed by melting Arctic ice to the nation’s Communications, Transportation Systems, or Water and Wastewater Systems Sectors, this hazard is assigned a value of (1) Negligible impact for each of these lifeline sectors. Based on these values, melting Arctic ice is found to pose a medium risk to the Energy Sector and a low risk to the Communications, Transportation Systems, and Water and Wastewater Systems Sectors. These findings are summarized in Table 5.

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<sup>180</sup> F. Stewart Chapin III et al., “Alaska,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, 518.

Table 5. Melting Arctic Ice—Risk Assessment Matrix<sup>181</sup>

HAZARD	SECTOR	RISK		Probability	Impact
		VERY HIGH (16-20)	HIGH (11-15)		
Melting Arctic Ice	Communications	LOW	4	4	1
	Energy	MEDIUM	8	4	2
	Transportation	LOW	4	4	1
	Water & Wastewater	LOW	4	4	1
<b>Probability :</b>					
4 = Highly Likely - near 100% probability in the next year					
3 = Likely - between 10% and 100% probability in the next year, or at least one chance in the next 10 years					
2 = Possible - between 1% and 10% probability in the next year, or at least one chance in the next 10 years					
1 = Unlikely - less than 1% probability in the next 100 years					
<b>Impact</b>					
4 = Catastrophic - multiple deaths; shutdown of critical facilities for 1 month or more; more than 50% of property severely damaged					
3 = Critical - injuries or illness resulting in permanent disability; shutdown of critical facilities for at least 2 weeks; 25% to 50% of property severely damaged					
2 = Limited – temporary injuries; shutdown of critical facilities for 1-2 weeks; 10% to 25% of property severely damaged					
1 = Negligible – injuries treatable with first aid; shutdown of critical facilities for 24 hours or less; less than 10% of property severely damaged					

## F. RISK ASSESSMENT: SEA-LEVEL RISE

### 1. Communications Sector

Identifying the vulnerability of the Communications Sector to sea-level rise is complicated by the complexity of the sector’s use of physical and virtual assets, and extreme reliance on the Energy Sector. In one case:

The resilience of the assets, programs, technology, and systems that compose the communications infrastructure reduce the likelihood of a significant national-level network failure. For example, the sector achieves resilience through the technology and redundancy employed in designing networks and by encouraging customers to employ diverse primary and backup communications capabilities.<sup>182</sup>

<sup>181</sup> Adapted from the Emergency Management Institute’s *IS-230.a Fundamentals of Emergency Management*.

<sup>182</sup> “2010 Communications Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 222.

Conversely, the *2010 Communications Sector-Specific Plan* reports a national communication security risk assessment found:

The communications network does not have to be nationally degraded or disrupted to cause national impacts. For example, a limited local outage could result in national impacts if a key government or commercial user, who is extremely dependent on the communications network, is affected and the nature of the effects lead to significant impacts.<sup>183</sup>

During Hurricane Sandy, the primary causes for loss of or reduced communications capabilities was flooding of major telephone hubs caused by storm surge.<sup>184</sup> Higher sea levels contribute to more destructive storm surge and in the case of Hurricane Sandy, an eight-inch rise in sea level along the impacted coastline contributed to a nine-foot storm surge that “exposed an additional 75,000 people and \$8.9 billion in property in New York City.”<sup>185</sup> This was exacerbated by power outages when power substations were also inundated by storm surge.<sup>186</sup> Despite having back-up generators, some critical communications facilities could not function because the generators were flooded, or fuel was unavailable due to a disruption in the fuel transportation system.<sup>187</sup>

## **2. Energy Sector**

Many of the facilities critical to the Energy Sector are located in areas that are threatened by sea-level rise because “power plants, oil and gas refineries, storage tanks transformers, and electricity transmission lines are often located directly on coastal

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<sup>183</sup> “2010 Communications Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 231.

<sup>184</sup> Linda I. Gibbs and Caswell F. Holloway. “Hurricane Sandy After Action: Report and Recommendations to Mayor Michael R. Bloomberg,” May 2013, 24, [http://www.nyc.gov/html/recovery/downloads/pdf/sandy\\_aar\\_5.2.13.pdf](http://www.nyc.gov/html/recovery/downloads/pdf/sandy_aar_5.2.13.pdf).

<sup>185</sup> “Storm Surge and Sea Level Rise: Advancing Waters,” Climate Central, accessed February 19, 2016, <http://www.climatecentral.org/gallery/graphics/storm-surge-and-sea-level-rise-advancing-waters>.

<sup>186</sup> Gibbs and Holloway, “Hurricane Sandy After Action: Report and Recommendations to Mayor Michael R. Bloomberg,” 14.

<sup>187</sup> Alex Kwasinski, “Hurricane Sandy Effects on Communications Systems (Preliminary Report)” (University of Texas at Austin PR-AK-0112-2012), December 4, 2012, <http://users.ece.utexas.edu/~kwasinski/preliminary%20telecom%20report%20v3%20comp.pdf>.

floodplain.”<sup>188</sup> Figure 4 identifies energy facilities that are located less than four feet above the tide line.

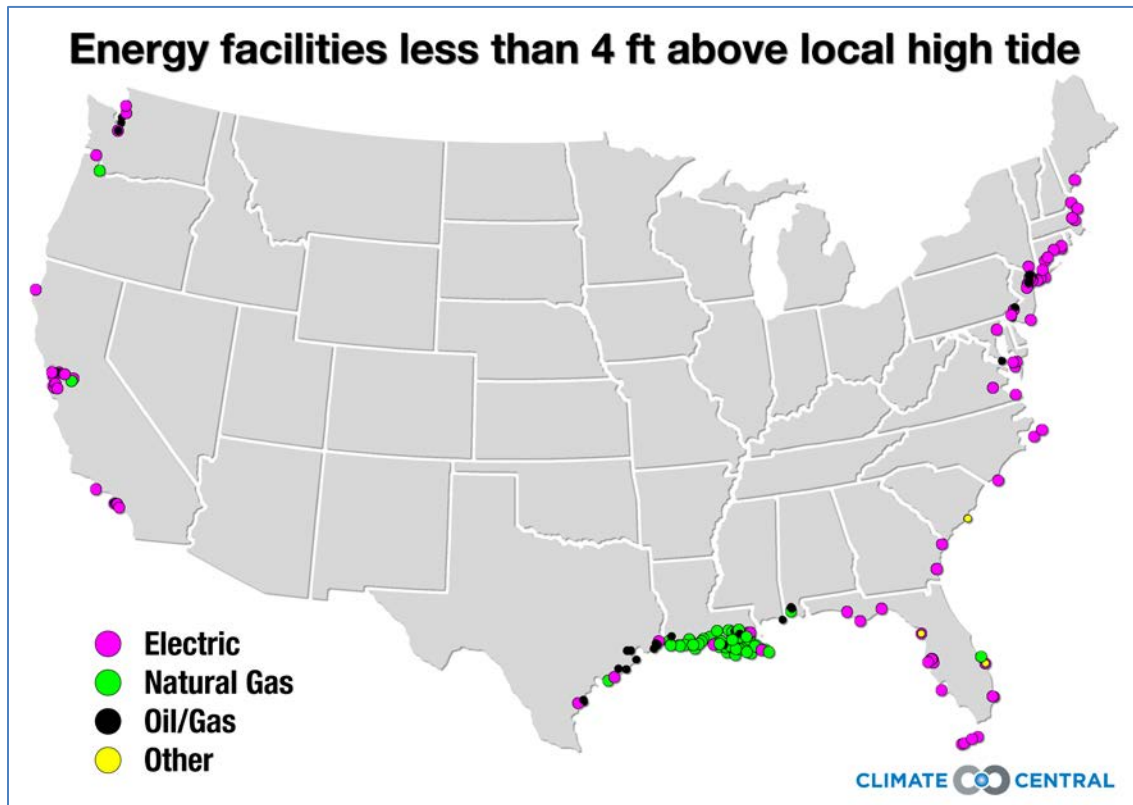


Figure 4. Low-Lying Coastal Energy Facilities Map<sup>189</sup>

The United States Department of Energy reports that by 2030, Alabama, Louisiana, Mississippi, and Texas will have “nearly \$1 trillion in energy assets at potential risk from rising sea levels and more intense hurricanes.”<sup>190</sup> The Gulf Coast is home to “nearly 4,000 active oil and gas platforms, more than 30 refineries, and 25,000 miles of pipeline, the Gulf region’s oil and gas industry produces approximately 50

<sup>188</sup> Jerry M. Melillo, *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*, 89.

<sup>189</sup> Source: “Sea Level Rise Threats to Energy Sector,” Climate Central, <http://slr.s3.amazonaws.com/SLR-Threats-to-Energy-Infrastructure.pdf>.

<sup>190</sup> “U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather,” U.S. Department of Energy, July 2013, 39, accessed November 18, 2015, <http://energy.gov/sites/prod/files/2013/07/f2/20130716-Energy%20Sector%20Vulnerabilities%20Report.pdf>.

percent of U.S. crude oil and natural gas and contains nearly half of the total U.S. refining capacity.”<sup>191</sup> Major products that pass through coastal ports are also impacted, as “roughly two-thirds of all U.S. oil imports are transported through this region, and pipelines traversing the region transport over 90 percent of domestic Outer Continental Shelf oil and gas.”<sup>192</sup> Also, the U.S. Strategic Petroleum Reserve (SPR), “the world’s largest supply of emergency crude oil...is stored in large underground salt caverns along the Gulf Coast. Approximately 700 million barrels of crude oil are stored in the SPR’s four storage sites, providing an available supply of crude oil in the event of an emergency.”<sup>193</sup>

Energy Sector facilities are also threatened along the California Coast. In 2012, the Lawrence Berkeley National Laboratory published the results of a study on the California energy infrastructure and the risks posed by climate change. Among other threats, the study found that “up to 25 current coastal power plants and 86 substations are at risk of flooding or compromised operation due to sea level rise.”<sup>194</sup> Forty-nine of the identified substations are located in the Bay Area. Figure 5 identifies the 25 coastal power plants.

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<sup>191</sup> “U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather,” 30.

<sup>192</sup> Virginia R. Burkett et al., “Why Study the Gulf Coasts?,” in *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I*, eds. Michael J. Savonis, Virginia R. Burkett, and Joanne R. Potter (Washington, DC: Department of Transportation, 2008), 2–1, accessed April 14, 2014, <http://downloads.globalchange.gov/sap/sap4-7/sap4-7-final-all.pdf>.

<sup>193</sup> *Ibid.*, 32.

<sup>194</sup> Jayant Sathaye et al., “Estimating Risk to California Energy Infrastructure from Projected Climate Change” (California Energy Commission Publication Number: CEC-500-2012-057) (Berkeley, CA: Lawrence Berkeley National Laboratory, 2012), iv, <http://www.energy.ca.gov/2012publications/CEC-500-2012-057/CEC-500-2012-057.pdf>.

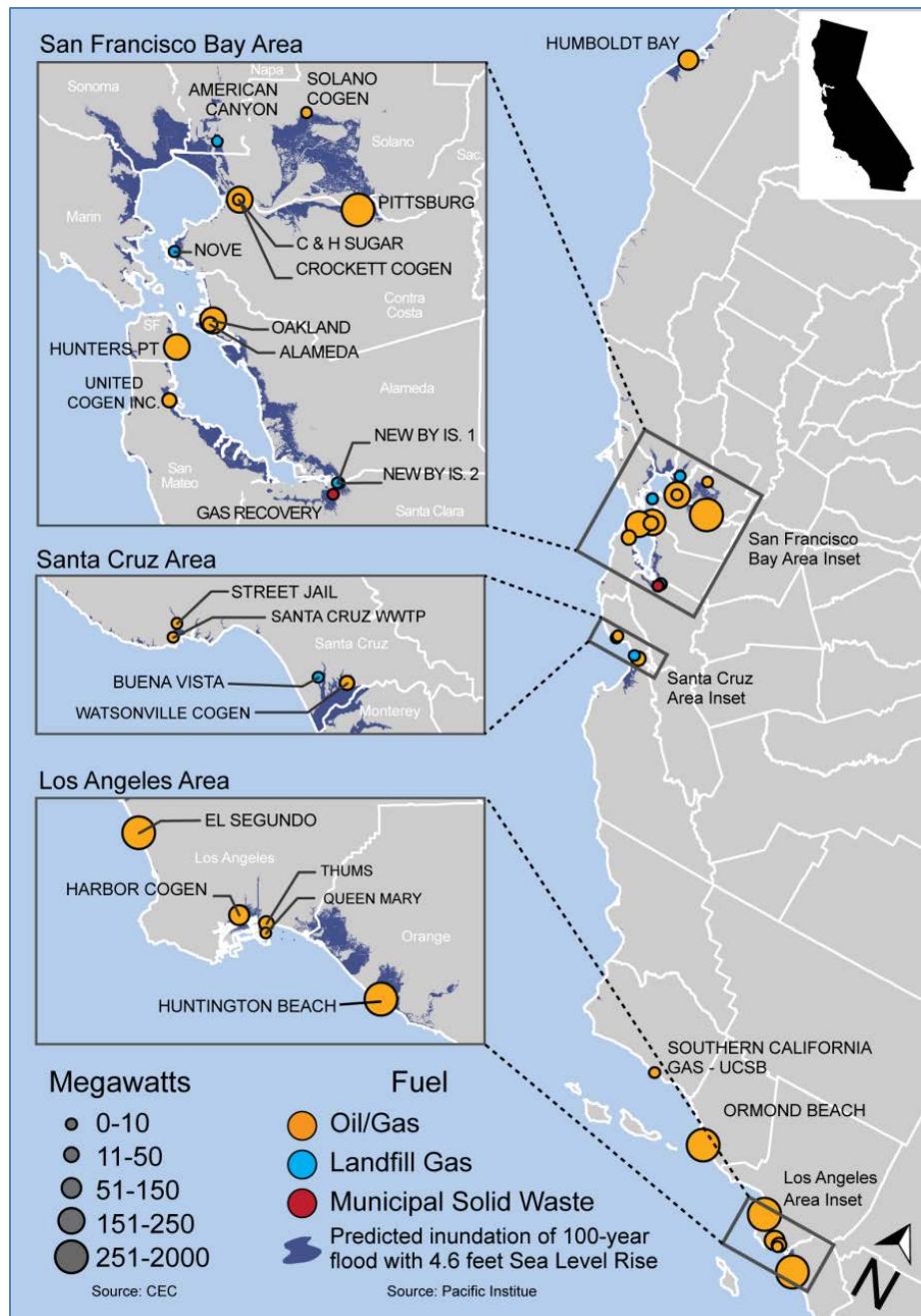


Figure 5. Power Plants Threatened by Sea-Level Rise—Pacific Coast<sup>195</sup>

<sup>195</sup> Source: Jan Dell et al., “Energy Supply and Use” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, eds. J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe (Washington, DC: U.S. Global Change Research Program, 2014), 119, <http://nca2014.globalchange.gov/report/sectors/energy>.



According to *Climate Change Impacts in the United States: The Third National Climate Assessment*:

Rising sea levels will combine with storm surges and high tides to threaten power-generating facilities located in California coastal communities and around the San Francisco Bay. Sea level rise and more intense heavy precipitation events increase the risk of coastal flooding and damages to infrastructure.<sup>196</sup>

The United States Environmental Protection Agency reports that sea-level rise in the Northeast “has risen by approximately 1 foot since 1900, which has caused more frequent flooding of coastal areas.”<sup>197</sup> By the end of this century, it is anticipated this level could increase four feet and is “likely to disrupt and damage important infrastructure, including communication systems, energy production, transportation, waste management, and access to clean water.”<sup>198</sup> Figure 6 illustrates a four-foot rise in sea level along the Atlantic seaboard.

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<sup>196</sup> Jan Dell et al., “Energy Supply and Use” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, 117.

<sup>197</sup> “Climate Change and the U.S. Energy Sector: Regional Vulnerabilities and Resilience Solutions,” U.S. Department of Energy Office of Energy Policy and Systems Analysis (October 2015), 7–6, [http://www.energy.gov/sites/prod/files/2015/10/f27/Regional\\_Climate\\_Vulnerabilities\\_and\\_Resilience\\_Solutions\\_0.pdf](http://www.energy.gov/sites/prod/files/2015/10/f27/Regional_Climate_Vulnerabilities_and_Resilience_Solutions_0.pdf).

<sup>198</sup> Ibid.

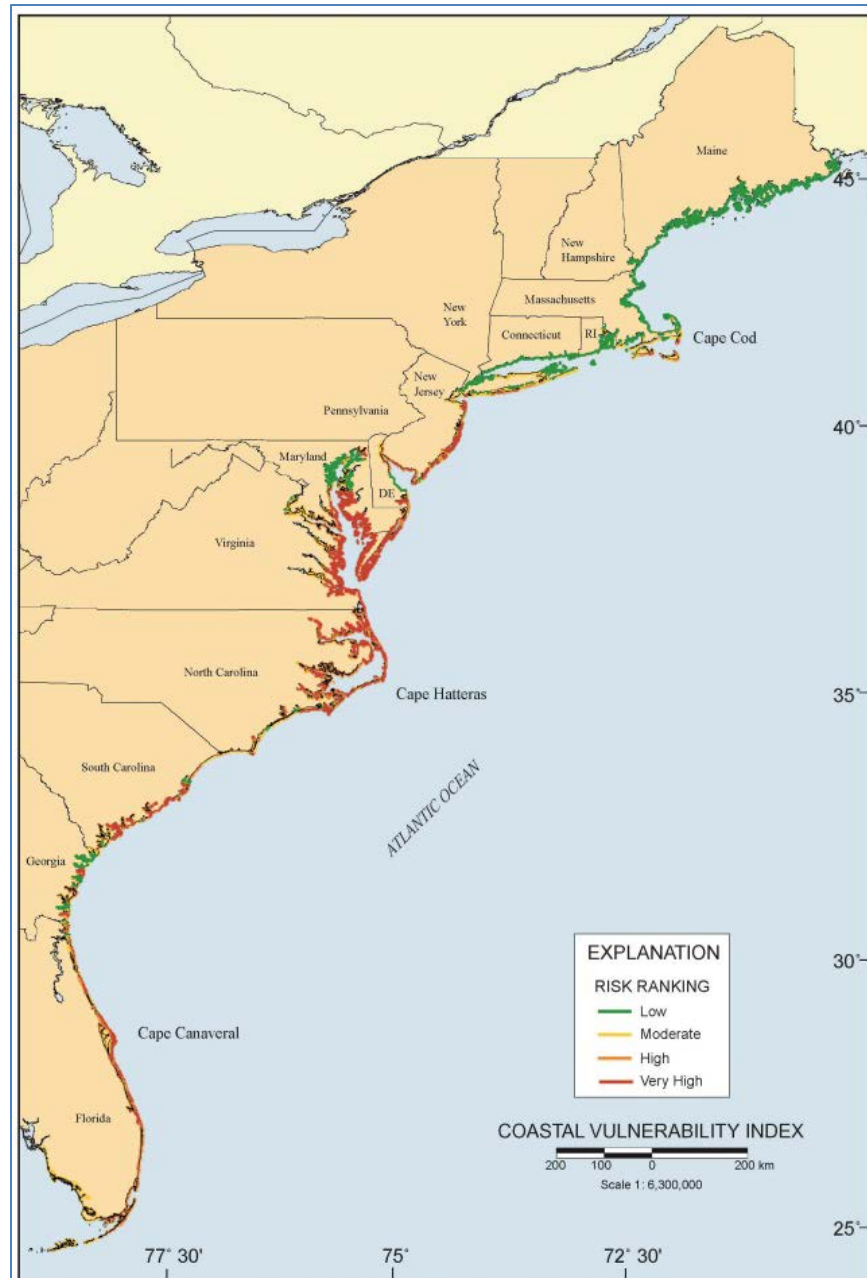


Figure 6. Sea-Level Rise Projection—Atlantic Coast<sup>199</sup>

<sup>199</sup> Source: E. Robert Thieler and Erika S. Hammar-Klose. "National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Atlantic Coast," U.S. Geological Survey Woods Hole, Massachusetts, 2000, <http://pubs.usgs.gov/dds/dds68/reports/gulfrep.pdf>.

### 3. Transportation Systems Sector

The Transportation Systems Sector is critical to the economic stability of the United States as it moves essential products and services such as energy, food, manufacturing, and trade goods.<sup>200</sup> Included in this system are ports, airports, rail terminals, roads, bridges, locks, canals, light rail, subways, freight and commuter railways; and pipelines.<sup>201</sup> The Committee on Climate Change and U.S. Transportation finds that “the greatest impact of climate change for North America’s transportation systems will be flooding of coastal roads, railways, transit systems, and runways because of global rising sea levels, coupled with storm surges and exacerbated in some locations by land subsidence.”<sup>202</sup>

Transportation systems within the Gulf Coast area are critical to the movement of domestic and international goods. Agricultural exports and oil imports are two of the major products that pass through ports located within this area. “Roughly two-thirds of all U.S. oil imports are transported through this region, and pipelines traversing the region transport over 90 percent of domestic Outer Continental Shelf oil and gas.”<sup>203</sup> Further, a U.S. Department of Transportation study on this area found “that 27 percent of the major roads, nine percent of rail lines, and 72 percent of ports are at or below four feet in elevation and are at risk to flooding within the first half century and perhaps even permanent inundation by the end of the century.”<sup>204</sup> Figure 7 identifies major transportation hubs in the Gulf Coast region that are threatened by sea-level rise.

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<sup>200</sup> Henry G. Schwartz et al., “Transportation,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, 131.

<sup>201</sup> Ibid.

<sup>202</sup> “Potential Impacts of Climate Change on U.S. Transportation,” National Research Council of the National Academies, 191.

<sup>203</sup> Virginia R. Burkett et al., “Why Study the Gulf Coasts?,” 2–1.

<sup>204</sup> “Climate Impacts and U.S. Transportation: Technical Input Report for the National Climate Assessment, Draft (OST/P-33),” U.S. Department of Transportation, February 2012, 28–29, <http://data.globalchange.gov/file/b59e7402-064e-4a01-8a5c-5c7f7235eb31>.

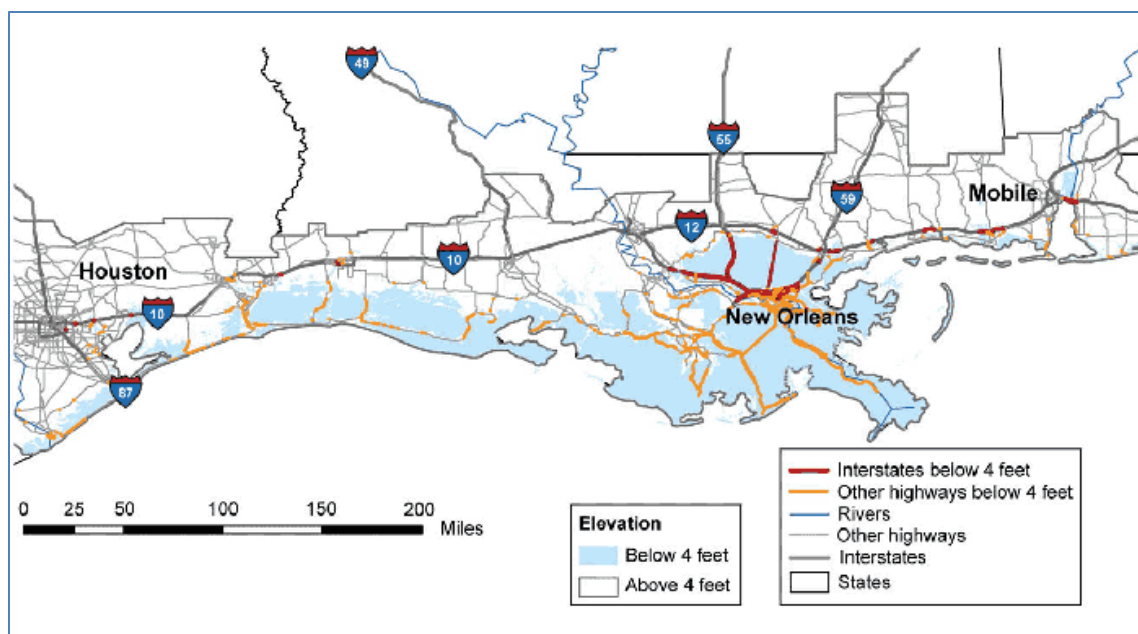


Figure 7. Gulf Coast Transportation Hubs at Risk<sup>205</sup>

Coastal ports will also experience significant impacts due to “a combination of sea level rise, storm surges, erosion, and land subsidence.”<sup>206</sup> This includes “three of the most important for imports and exports: Los Angeles/Long Beach (which handles 31 percent of the U.S. port container movements) and the Port of South Louisiana and the Port of Galveston/Houston (which combined handle 25 percent of the tonnage handled by U.S. ports).”<sup>207</sup> Additionally, “1) as sea level rises, bridge clearance may not be adequate to allow safe passage of large vessels; 2) even if the elevation of port facilities is adequate, any main access road that is not elevated will become more frequently inundated, thus affecting port operations.”<sup>208</sup> Also at risk are “thirteen of the nation’s 47 largest airports.”<sup>209</sup> Disruption to air travel and freight shipments will also be intensified by the flooding of “access roads and public transportation systems that transport airport

<sup>205</sup> Source: Henry G. Schwartz et al., “Transportation,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, 135.

<sup>206</sup> Henry G. Schwartz et al., “Transportation,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, 134.

<sup>207</sup> Ibid.

<sup>208</sup> Ibid.

<sup>209</sup> Ibid.

workers and passengers to and from the facilities.”<sup>210</sup> Figure 8 identifies the 13 major airports that are threatened by sea-level rise.

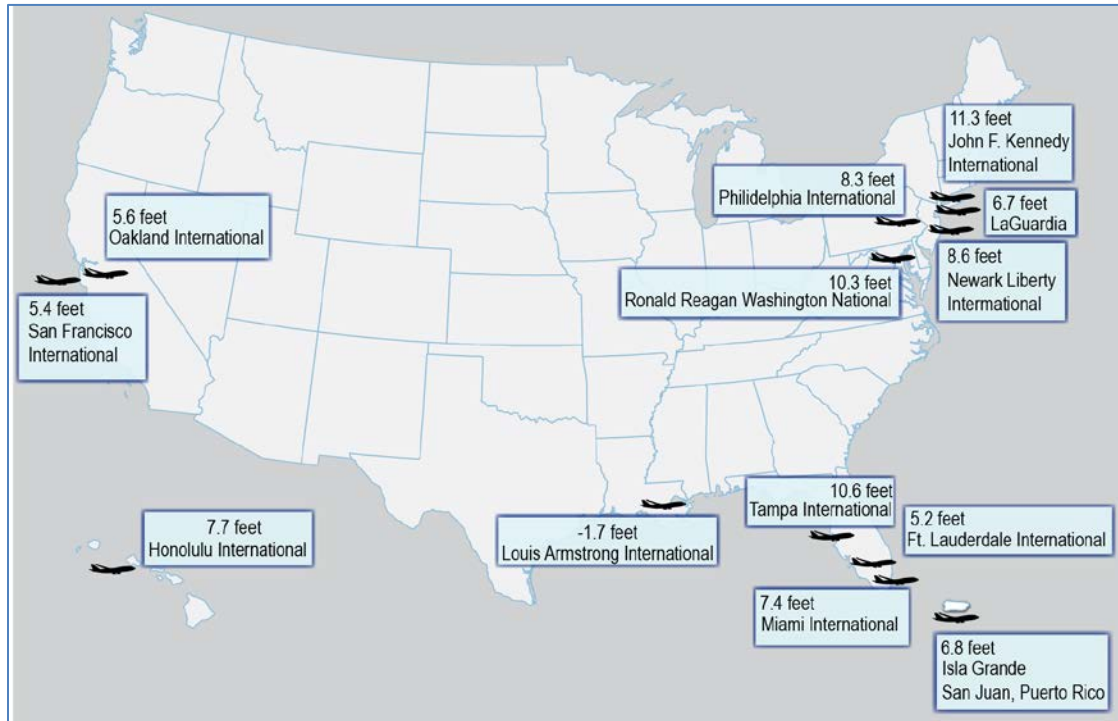


Figure 8. Airports Vulnerable to Storm Surge<sup>211</sup>

#### 4. Water and Wastewater Systems Sector

Sea-level rise threatens the freshwater supply of coastal regions by increasing the “salinity of both surface water and ground water through salt water intrusion.”<sup>212</sup> One example of this occurs in the Everglades that recharge the Biscayne aquifer, the “primary water supply to the Florida Keys.”<sup>213</sup> Rising sea levels can also push saltwater farther upstream into freshwater rivers impacting aquifers in low-lying areas such as New

<sup>210</sup> Andrew Freedman, “U.S. Airports Face Increasing Threat from Rising Seas,” Climate Central, June 18, 2013, <http://www.climatecentral.org/news/coastal-us-airports-face-increasing-threat-from-sea-level-rise-16126>.

<sup>211</sup> Source: Henry G. Schwartz et al., “Transportation,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, 134.

<sup>212</sup> “Climate Impacts on Water Resources,” United States Environmental Protection Agency, accessed February 13, 2016, <https://www3.epa.gov/climatechange/impacts/water.html>.

<sup>213</sup> Ibid.

Jersey.<sup>214</sup> Groundwater aquifers are also threatened along the Pacific coastline and “seawater intrusion is already problematic in California’s coastal aquifers throughout Central and Southern California, including the Pajaro and Salinas Valleys and aquifers in Orange and Los Angeles Counties.”<sup>215</sup>

Wastewater treatment plants are also threatened in coastal communities because they are “typically located at low elevations to take advantage of gravity-fed sewage collection.”<sup>216</sup> Coastal flooding also puts these plants at risk from saltwater intrusion that will “damage pumps and other equipment, and lead to untreated sewage discharges.”<sup>217</sup> During Hurricane Sandy, “more than 10 billion gallons of sewage spilled into waterways and neighborhoods.”<sup>218</sup> Figure 9 identifies wastewater treatment plants located along the California coastline.

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<sup>214</sup> “Climate Impacts on Water Resources,” United States Environmental Protection Agency.

<sup>215</sup> Matthew Heberger et al., “The Impacts of Sea Level Rise on the California Coast,” California Climate Change Center, 2009, 80, <http://pacinst.org/wp-content/uploads/sites/21/2014/04/sea-level-rise.pdf>.

<sup>216</sup> Susan C. Moser et al., “Coastal Zone Development and Ecosystems” in *Climate Change Impacts in the United States: The Third National Climate Assessment* eds., J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe (Washington, DC: U.S. Global Change Research Program, 2014), 587, <http://nca2014.globalchange.gov/report/regions/coasts>.

<sup>217</sup> Matthew Heberger et al., “The Impacts of Sea Level Rise on the California Coast,” 80.

<sup>218</sup> Ben Bovarnick, Shiva Polefka, and Arpita Bhattacharyya, *Rising Waters, Rising Threat: How Climate Change Endangers America’s Neglected Wastewater Infrastructure*. (Washington, DC: Center for American Progress October 2014), 8, <https://cdn.americanprogress.org/wp-content/uploads/2014/10/wastewater-report.pdf>.

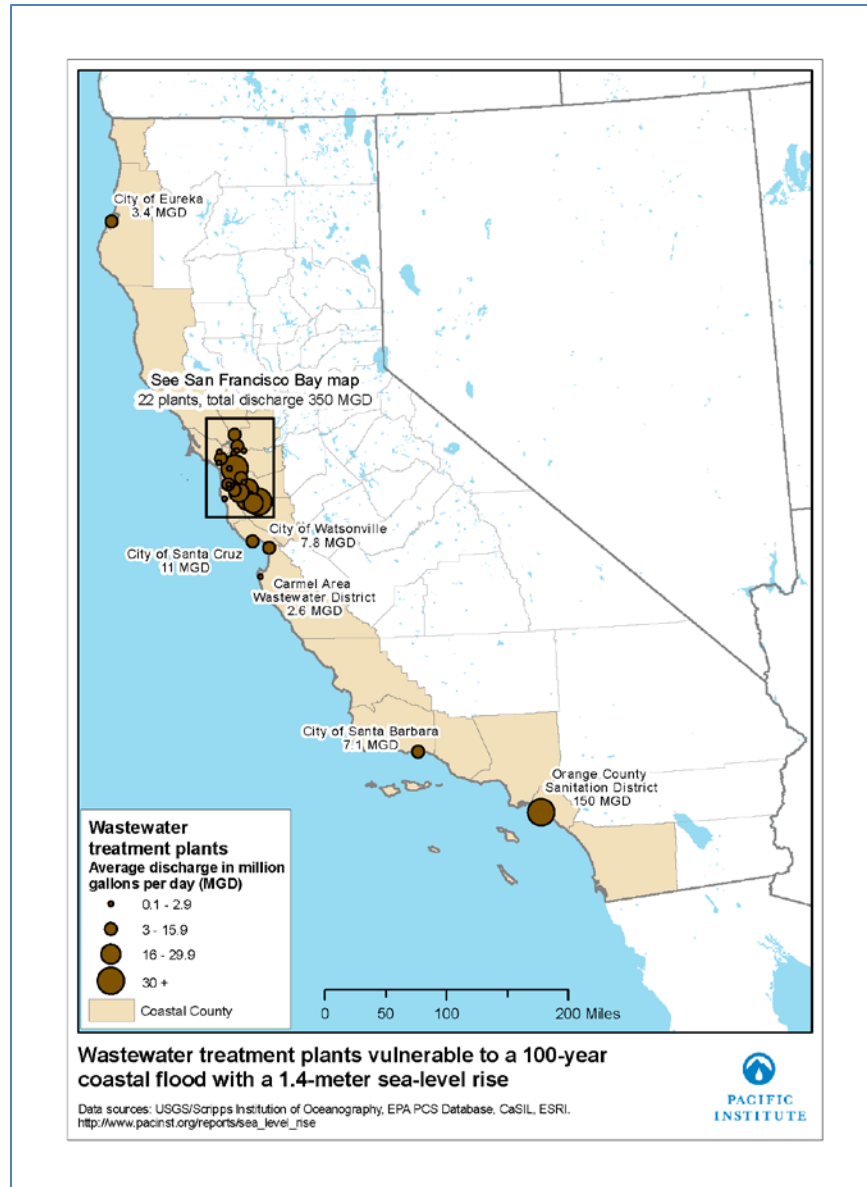


Figure 9. Wastewater Treatment Plants—California Coast<sup>219</sup>

## 5. Risk Assessment Matrix—Sea Level Rise

Varying degrees of sea-level rise is well documented along the Atlantic, Gulf, and Pacific Coasts of the United States. Research also substantiates that sea-level rise exacerbates coastal flooding and storm surge during severe storms such as hurricanes.

<sup>219</sup> Source: Pacific Institute, accessed February 20, 2016, [http://pacinst.org/wp-content/uploads/sites/21/2009/02/Fig24\\_WWTP\\_CA.pdf](http://pacinst.org/wp-content/uploads/sites/21/2009/02/Fig24_WWTP_CA.pdf).

According to a report published by the Environmental Protection Agency, “since 1878 about six to seven hurricanes have formed in the North Atlantic every year. Roughly two per year make landfall in the United States.”<sup>220</sup> Based on these findings sea level rise is assigned a probability value of (4) Highly Likely for each of the lifeline sectors.

The events of Hurricane Sandy are an example of a localized degradation or disruption in communications that did not result in a national impact. Therefore, it could be extrapolated that sea-level rise poses a negligible risk to the nation’s Communications Sector. However, given the national impacts a localized or limited loss of communications could have “if a key government or commercial user...is affected and the nature of the effects lead to significant impacts,”<sup>221</sup> sea-level rise is assigned a value of (2) Limited impact. Based on the factors of a Highly Likely probability and Limited impact, sea-level rise is determined to pose a medium risk to the Communications Sector.

Hurricane Sandy serves as an example of the threat to the Energy Sector that exists along the Atlantic Coast. In this case, eight inches of sea-level rise contributed to a nine-foot storm surge impacting thousands of people and billions of dollars in property.<sup>222</sup> According to a report published by the National Oceanic and Atmospheric Administration “power outages from the combined effects of wind and surge left some coastal communities in New Jersey without power for months.”<sup>223</sup> Based on the cumulative number of energy infrastructure exposed to sea level rise; the extent of their importance to the U.S. Energy Sector; and the length of time they may be shut down, the impact of sea-level rise to the Energy Sector is assigned a value of (4) Catastrophic impact. Based on the factors of a Highly Likely probability and Catastrophic impact, sea-level rise is determined to pose a very high risk to the Energy Sector.

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<sup>220</sup> “Climate Change Indicators in the United States: Tropical Cyclone Activity,” United States Environmental Protection Agency, 2, accessed May 1, 2016, [https://www3.epa.gov/climatechange/pdfs/print\\_cyclones-2015.pdf](https://www3.epa.gov/climatechange/pdfs/print_cyclones-2015.pdf).

<sup>221</sup> “2010 Communications Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan,” U.S. Department of Homeland Security, 231.

<sup>222</sup> “Storm Surge and Sea Level Rise: Advancing Waters,” Climate Central.

<sup>223</sup> “Service Assessment: Hurricane/Post-Tropical Cyclone Sandy,” National Oceanic and Atmospheric Administration, October 22–29, 2012, May 2013, 1, accessed May 30, 2016, <http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf>.



Storm surge during Hurricane Sandy is credited with “some of the most devastating impacts, including flooding in New York City’s subway tunnels, water overtopping runways at La Guardia and Kennedy airports, and damage to the New Jersey Transit System estimated at approximately \$400 million.”<sup>224</sup> Impacts to the Transportation Systems Sector left commuters in New York without reliable public transportation for four days. The use of personal vehicles was severely limited during this same period because 38 percent of gas stations in the Metropolitan New York had no gasoline for sale.<sup>225</sup> Based on the length of time transportation systems were shut down during Hurricane Sandy and the number of critical transportation hubs that are exposed to sea-level rise, this hazard is assigned a value of (2) Limited impact. Based on the factors of a Highly Likely probability and Limited impact, sea-level rise is determined to pose a medium risk to the Transportation Systems Sector.

Saltwater intrusion into freshwater supply is documented along the nation’s coastlines. This intrusion not only threatens groundwater aquifers but also damages pumps and other components that are used in water- and wastewater-treatment plants. Sea-level rise also contributed to untreated sewage from surge-damaged wastewater treatment plants to flow into waterways in New Jersey and New York for up to a month after Hurricane Sandy.<sup>226</sup> Based on the number of water and wastewater treatment plants that are exposed to sea-level rise and the length of time plants were shut down because of the storm-surge from Hurricane Sandy, this hazard is assigned a value of (3) Critical impact. Based on the factors of Highly Likely probability and Critical impact, sea-level rise is determined to pose a high risk to the Water and Wastewater Systems Sector. The findings of the sea-level rise risk assessment are summarized in Table 6.

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<sup>224</sup> “Service Assessment: Hurricane/Post-Tropical Cyclone Sandy,” iv.

<sup>225</sup> “Hurricane Sandy Fast Facts,” CNN, accessed May 30, 2016, <http://www.cnn.com/2013/07/13/world/Americas/hurricane-sandy-fast-facts/index.html>.

<sup>226</sup> Michael Schwartz, “Sewage Flows After Storm Expose Flaws in System,” *New York Times*, accessed May 30, 2016, <http://www.nytimes.com/2012/11/30/nyregion/sewage-flows-after-hurricane-sandy-exposing-flaws-in-system.html>.

Table 6. Sea Level Rise—Risk Assessment Matrix<sup>227</sup>

HAZARD	SECTOR	RISK		Probability	Impact
		VERY HIGH(16-20)	HIGH (11-15)		
		MEDIUM (6-10)	LOW (1-5)		
Sea Level Rise	Communications	MEDIUM	8	4	2
	Energy	VERY HIGH	16	4	4
	Transportation	MEDIUM	8	4	2
	Water & Wastewater	HIGH	12	4	3
<b>Probability :</b>					
4 = Highly Likely - near 100% probability in the next year					
3 = Likely - between 10% and 100% probability in the next year, or at least one chance in the next 10 years					
2 = Possible - between 1% and 10% probability in the next year, or at least one chance in the next 10 years					
1 = Unlikely - less than 1% probability in the next 100 years					
<b>Impact</b>					
4 = Catastrophic - multiple deaths; shutdown of critical facilities for 1 month or more; more than 50% of property severely damaged					
3 = Critical - injuries or illness resulting in permanent disability; shutdown of critical facilities for at least 2 weeks; 25% to 50% of property severely damage					
2 = Limited – temporary injuries; shutdown of critical facilities for 1-2 weeks; 10% to 25% of property severely damaged					
1 = Negligible – injuries treatable with first aid; shutdown of critical facilities for 24 hours or less; less than 10% of property severely damaged					

## G. RISK ASSESSMENT: DROUGHT

### 1. Energy Sector

The United States Department of Homeland Security's Office of Cyber and Infrastructure Analysis (OCIA) identifies the Energy Sector as one that is most vulnerable to drought.<sup>228</sup> According to a report published by the OCIA, "all sources of energy (including electricity) require water in their production processes including extracting raw materials, cooling in thermal processes, cleaning processes, cultivating crops for biofuels, and powering turbines."<sup>229</sup> The report also states "severe drought could curtail power production in the Pacific Northwest, which is strongly dependent on

<sup>227</sup> Adapted from the Emergency Management Institute's *IS-230.a Fundamentals of Emergency Management*.

<sup>228</sup> "Drought Impacts to Critical Infrastructure," U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, April 23, 2015, 1, [http://content.govdelivery.com/attachments/USDHSFACIR/2015/04/30/file\\_attachments/386534/Drought%2BImpacts%2Bto%2BCritical%2BInfrastructure.pdf](http://content.govdelivery.com/attachments/USDHSFACIR/2015/04/30/file_attachments/386534/Drought%2BImpacts%2Bto%2BCritical%2BInfrastructure.pdf).

<sup>229</sup> *Ibid.*, 8.

hydroelectric power, by up to 22 percent. Under the same drought conditions, the Texas Gulf Coast Basin would lose 25 percent of its production, due to its dependence on water for cooling its fossil-fuel plants.”<sup>230</sup>

Recent events have heightened the awareness of this dependency and demonstrated that the limited availability of water due to drought greatly impacts the resiliency of the Energy Sector.<sup>231</sup> A report published in December 2014 identifies these impacts as reduction in oil and gas production, delays in the delivery of crude oil, petroleum products and coal due to low or high river flows; and a decrease in the production of bioenergy fuel because of limited water for irrigation.<sup>232</sup>

## **2. Communications Sector**

According to the Office of Cyber and Infrastructure Analysis, “Communications equipment and information technology data centers use water for cooling. Data centers, for example, often use high-tonnage heating, ventilating, and air conditioning systems that require drinkable water to operate in order to keep their computer systems cool.”<sup>233</sup> Also “submarine telecom cables” that are installed in rivers and lakes are susceptible to damage if water levels fall.<sup>234</sup> Additionally, drought conditions in parts of the country have increased the risk of wildfires. For instance, in the Southwest wildfires are “more likely and dangerous, damaging electric transmission and distribution systems as well as wooden electrical and communication poles and aerial equipment, including fiber optic and copper lines, microwave towers, and equipment in vaults.”<sup>235</sup>

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<sup>230</sup> “Drought Impacts to Critical Infrastructure,” 8.

<sup>231</sup> “U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather,” U.S. Department of Energy, 32.

<sup>232</sup> Molly Hellmuth et al., *Assessment of Climate Change Risks to Energy Reliability in the WECC Region*, 11–12.

<sup>233</sup> “Drought Impacts to Critical Infrastructure,” U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 9.

<sup>234</sup> *Ibid.*

<sup>235</sup> *Ibid.*

### **3. Transportation Systems Sector**

Drought is most closely identified with the risk it poses to the Food and Agriculture and Energy Sectors. However, “[persistent] drought conditions have the potential to limit port and waterway transportation operations by reducing routes available and limiting cargo carrying capacity, resulting in increased transportation cost.”<sup>236</sup> For instance, the closure of the barge industry on the Mississippi River in 1988 (when water levels fell) cost “the U.S. barge industry an estimated \$1 billion.”<sup>237</sup>

The high temperatures that often accompany drought conditions can cause land subsidence resulting in damaged roadways, runways, rail line buckling and expansion of bridge joints.<sup>238</sup> While it is reported that pipelines are not likely to be impacted by the extreme heat, land subsidence cannot be ruled out as a threat.

### **4. Water and Wastewater Systems Sector**

The Office of Cyber and Infrastructure Analysis also identifies the Water and Wastewater Systems Sector as one at that is most vulnerable to drought.<sup>239</sup> According to the report:

Nationally, groundwater from aquifers supplies about 33 percent of the public water supply and provides drinking water for more than 97 percent of the rural population. If groundwater is depleted more quickly than it is replenished, which may happen during a drought, aquifer levels can drop, making water unavailable for irrigation and consumption.<sup>240</sup>

The Southeast, Great Plains, and Southwest regions of the United States primarily use groundwater as the main water source. These areas have also been impacted by drought in recent years and are projected to have increasing water demands as drought

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<sup>236</sup>236 “Drought Impacts to Critical Infrastructure,” U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 9.

<sup>237</sup> Ibid.

<sup>238</sup> “Potential Impacts of Climate Change on U.S. Transportation,” National Research Council, Committee on Climate Change and U.S. Transportation, 86.

<sup>239</sup> “Drought Impacts to Critical Infrastructure,” U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 7.

<sup>240</sup> Ibid.

conditions continue to fluctuate and temperatures rise.<sup>241</sup> This increase in water demand and declining water recharge rates threaten “the sustainability of many aquifers.”<sup>242</sup> In 2011, drought conditions and abnormally high temperatures in Texas and Oklahoma are credited with “depleting water resources and contributing to more than \$10 billion in direct losses to agriculture alone.”<sup>243</sup>

Drought conditions can also lead to contaminated water sources.<sup>244</sup> According to the Office of Cyber and Infrastructure Analysis, “water reservoirs may experience increased pollutant levels and lower levels of oxygen, contributing to higher concentrations of illness-causing bacteria and protozoa, as well as toxic blue-green algae blooms.”<sup>245</sup> Drought also contributes to an increase in “the salinity of both surface water and ground water through salt water intrusion.”<sup>246</sup> This occurs because lower levels in aquifers and rivers “can allow saltwater to move inland and also contaminate the water supply.”<sup>247</sup> This phenomenon also creates difficulties for wastewater treatment facilities because many are “not equipped to remove salts, which can cause problems not only for potable water but also for industrial uses. In July and August 2012, saline intrusion into drinking water was reported in Florida, South Carolina, and Louisiana.”<sup>248</sup> Wastewater treatment systems are also at risk for drought-related land subsidence when “aquifers are depleted and unsupported ground collapses.”<sup>249</sup> Land subsidence can impact water or wastewater pipes and “can result in unfiltered water entering from lakes and streams and,

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<sup>241</sup> Jerry M. Melillo, *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*, 43.

<sup>242</sup> *Ibid.*

<sup>243</sup> *Ibid.*, 77.

<sup>244</sup> “Drought Impacts to Critical Infrastructure,” U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 7.

<sup>245</sup> *Ibid.*

<sup>246</sup> “Water Resources,” United States Environmental Protection Agency.

<sup>247</sup> “Drought Impacts to Critical Infrastructure,” U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 7.

<sup>248</sup> *Ibid.*

<sup>249</sup> *Ibid.*

eventually, aquifers used as drinking water sources, sully the drinking water supply.<sup>250</sup>

## **5. Risk Assessment Matrix—Drought**

Droughts of note have plagued the Continental United States during the 20<sup>th</sup> century and fluctuated across the nation between the years of 2000 and 2014. During periods of drought, the availability of water is compromised by a shortfall or contamination of existing water supplies. Studies have shown that the lifeline sectors depend on an interrupted water supply for their continued operations. This is substantiated by the findings of the Office of Cyber and Infrastructure Analysis that identifies drought as a direct threat to each of the lifeline sectors. Based on these findings, drought is assigned a probability value of (4) Highly Likely for each of the lifeline sectors.

The intensity of drought conditions fluctuates across the United States and makes it difficult to ascertain a consistent level of drought's impact to the nation's lifeline sectors. However, based on research and the findings of the Office of Cyber and Infrastructure Analysis, I have extrapolated a value of (3) Critical impact. This value is substantiated by the statement in the *Long Term Drought Resilience: Federal Action Plan of the National Drought Resilience Partnership* that "extreme, widespread drought challenges the security of the U.S. food supply and the integrity of critical infrastructure, causes extensive economic impacts, and increases energy costs."<sup>251</sup> Based on the factors of Highly Likely probability and Critical impact, drought is determined to pose a high risk to each of the lifeline sectors. The findings of the drought risk assessment are summarized in Table 7.

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<sup>250</sup>250 "Drought Impacts to Critical Infrastructure," U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, 7.

<sup>251</sup> "Long Term Drought Resilience: Federal Action Plan of the National Drought Resilience Partnership," The White House, March 2016, 1, [https://www.whitehouse.gov/sites/default/files/docs/drought\\_resilience\\_action\\_plan\\_2016\\_final.pdf](https://www.whitehouse.gov/sites/default/files/docs/drought_resilience_action_plan_2016_final.pdf).

Table 7. Drought—Risk Assessment Matrix<sup>252</sup>

HAZARD	SECTOR	RISK		Probability	Impact
		VERY HIGH (16-20)	HIGH (11-15)		
Drought	Communications	HIGH	12	4	3
	Energy	HIGH	12	4	3
	Transportation	HIGH	12	4	3
	Water & Wastewater	HIGH	12	4	3
<b>Probability :</b>					
4 = Highly Likely - near 100% probability in the next year					
3 = Likely - between 10% and 100% probability in the next year, or at least one chance in the next 10 years					
2 = Possible - between 1% and 10% probability in the next year, or at least one chance in the next 10 years					
1 = Unlikely - less than 1% probability in the next 100 years					
<b>Impact</b>					
4 = Catastrophic - multiple deaths; shutdown of critical facilities for 1 month or more; more than 50% of property severely damaged					
3 = Critical - injuries or illness resulting in permanent disability; shutdown of critical facilities for at least 2 weeks; 25% to 50% of property severely damaged					
2 = Limited – temporary injuries; shutdown of critical facilities for 1-2 weeks; 10% to 25% of property severely damaged					
1 = Negligible – injuries treatable with first aid; shutdown of critical facilities for 24 hours or less; less than 10% of property severely damaged					

## H. CONCLUSION

This chapter presents the risk assessments performed to ascertain if slow-onset disasters pose a threat to the nation's critical infrastructure lifeline sectors: Communications, Energy, Transportation Systems and Water and Wastewater Systems Sectors. The results show ocean acidification poses a low risk to each of the lifeline sectors. Melting Arctic ice poses a medium risk to the Energy Sector but a low risk to the Communications, Transportation Systems and Water and Wastewater Systems Sectors. Sea-level rise poses a medium risk to the Communications and Transportation Systems Sectors; a high risk to the Water and Wastewater Systems; and a very high risk to the Energy Sector. Drought is found to pose a high risk to each of the lifeline sectors.

Having determined the level of risk slow-onset disasters pose to homeland security, the next step was to ascertain whether or not they are addressed by the homeland

<sup>252</sup> Adapted from the Emergency Management Institute's *IS-230.a Fundamentals of Emergency Management*.

security discipline. Chapter V provides an overview and analysis of the nation's current approach to homeland security and whether or not this approach recognizes and addresses slow-onset disasters.



## **V. RELEVANCE OF THE NATION'S APPROACH TO HOMELAND SECURITY**

The great thing in this world is not so much where we are, but in what direction we are moving.”

—Oliver Wendell Holmes

### **A. INTRODUCTION**

Drought and sea-level rise are the two slow-onset disasters I identified in Chapter IV as posing a high risk to homeland security. I also identified that occurrences of these types of disasters also pose a threat to the local communities where they occur and, in many cases, have cascading consequences that reach beyond the geographic borders of these communities. Having made these determinations, I moved to the final question posed in my thesis: Are slow-onset disasters adequately addressed in the homeland security discipline? Answering this question requires an understanding of emergency management and homeland security policies and the relationship that exists between these two disciplines.

### **B. RELATIONSHIP BETWEEN EMERGENCY MANAGEMENT AND HOMELAND SECURITY**

Between 1979 and 2001, FEMA utilized the “Integrated Emergency Management System, an all-hazards approach based on preparedness, response, recovery, and mitigation, which provided direction, control, and warning systems common to the full range of emergencies from small, isolated events to the ultimate emergency—war.”<sup>253</sup> This changed when the Homeland Security Act of 2002 created the Department of Homeland Security. Since that time there has been an ongoing debate on the relationship between the homeland security and emergency management disciplines. This debate supports the perception of a separation between the two—protecting the nation from terrorist acts lies solely within the homeland security domain while threats from natural

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<sup>253</sup> *Federal Emergency Management Agency Publication 1*, Federal Emergency Management Agency, November 2010, 7 [http://www.fema.gov/media-library-data/20130726-1823-25045-8164/pub\\_1\\_final.pdf](http://www.fema.gov/media-library-data/20130726-1823-25045-8164/pub_1_final.pdf).

hazards belong in the field of emergency management. As both of these disciplines are unarguably engaged in disaster consequence management, an understanding of their relationship is necessary to inform the scope of this chapter.

Emergency management is defined by William Waugh and Kathleen Tierney as “the managerial function charged with creating the framework within which communities reduce vulnerability to hazards and cope with disasters.”<sup>254</sup> The 2010 *Quadrennial Homeland Security Review* defines homeland security as “a concerted national effort to ensure a homeland that is safe, secure, and resilient against terrorism and other hazards where American interests, aspirations, and way of life can thrive.”<sup>255</sup> Based on these definitions, emergency management is a method for achieving the goal of homeland security and, therefore, is a critical component within the homeland security discipline. It is this perspective that informs the assessment of our nation’s methodology for a coordinated approach to homeland security and whether or not it adequately addresses slow-onset disasters.

### **C. COORDINATED APPROACH TO HOMELAND SECURITY**

The nation’s approach to homeland security includes two major pieces of legislation that enables the federal government to provide guidance and assistance to states for prevention, protection, mitigation, response, and recovery activities—The Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Homeland Security Act of 2002. Both of these are strengthened by policy directives that frame standardized tactics for the nation “to ensure a homeland that is safe, secure, and resilient against terrorism and other hazards.”<sup>256</sup> This includes “efforts to secure the infrastructures and assets vital to our national security, governance, public health and

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<sup>254</sup> William L. Waugh Jr. and Kathleen Tierney, eds., *Emergency Management: Principles and Practice for Local Government*, 2<sup>nd</sup> ed. (Washington, D.C.: International City/County Management Association, 2007), 17.

<sup>255</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U. S. Department of Homeland Security, 13.

<sup>256</sup> *Ibid.*

safety, economy, and public confidence.”<sup>257</sup> Figure 10 illustrates the nation’s coordinated approach to homeland security.

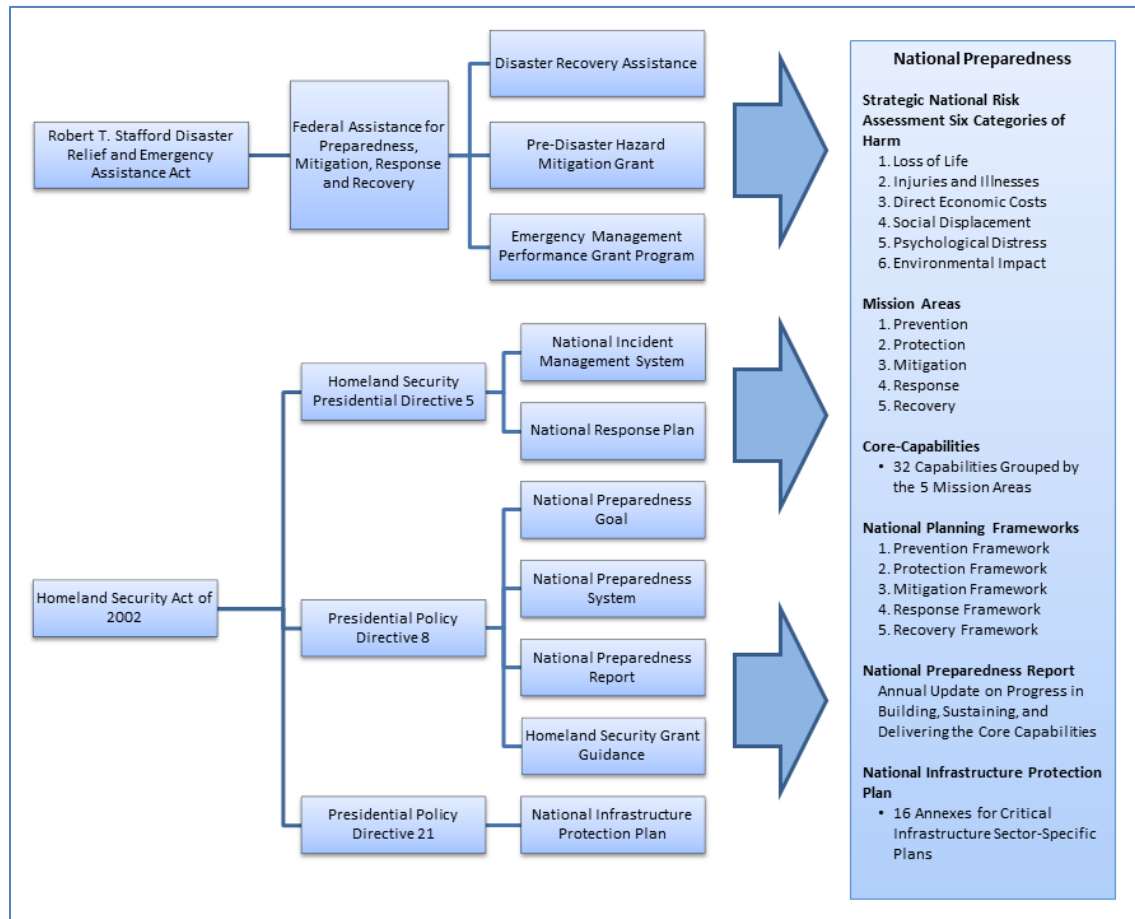


Figure 10. Coordinated Approach to Homeland Security

#### D. ROBERT T. STAFFORD DISASTER RELIEF AND EMERGENCY ASSISTANCE ACT

The primary authority for the provision of federal aid to state and local jurisdictions for preparedness, mitigation, response, and recovery activities is the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act). The genesis of this act begins with the Federal Disaster Relief Act of 1950 that authorizes the federal

<sup>257</sup> “The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets,” U.S. Department of Homeland Security, February 2003, vii, [https://www.dhs.gov/xlibrary/assets/Physical\\_Strategy.pdf](https://www.dhs.gov/xlibrary/assets/Physical_Strategy.pdf).

government “to provide supplementary Federal assistance when a Governor requested help and the President approved the request by declaring a major disaster.”<sup>258</sup> Prior to the passing of this act, requests for federal disaster relief required Congress to pass a separate law for each disaster. Following a number of amendments, the Disaster Relief Act eventually progressed to become the act we know today. The Stafford Act authorizes the issuance of major disaster or emergency declarations and provides federal assistance when state, local, or tribal jurisdiction’s response resources are overwhelmed. This act is also the enabling authority for preparedness grants and programs. One concept has remained constant regardless of the number of amendments to the Stafford act—federal assistance is intended “to supplement State and local efforts and capabilities to save lives and to protect property and public health and safety.”<sup>259</sup> Figure 11 illustrates the supplemental assistance that may be provided by the Stafford Act.

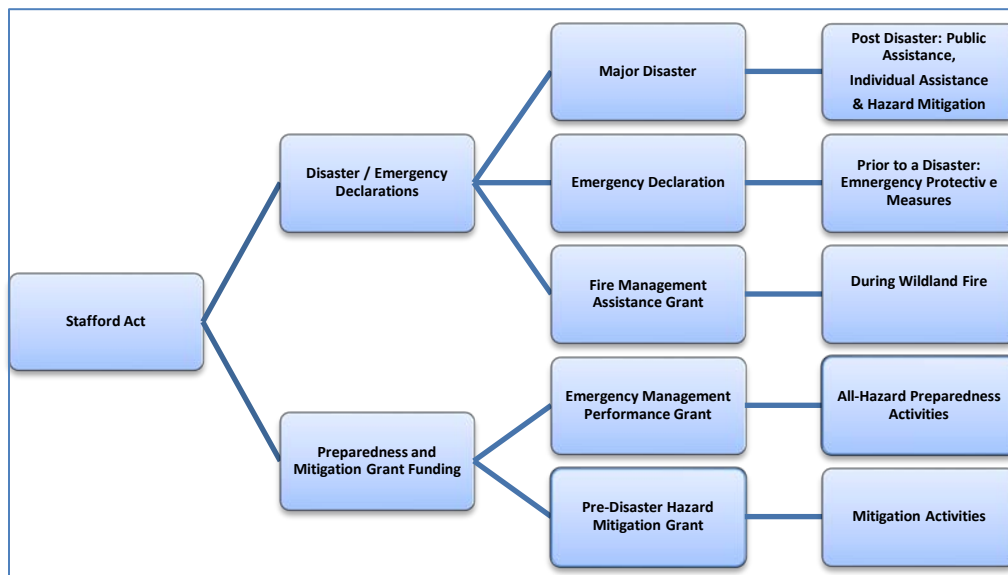


Figure 11. Stafford Act: Supplemental Assistance for Preparedness, Mitigation, Response and Recovery

<sup>258</sup> “IS-7 A Citizen’s Guide to Disaster Assistance,” Federal Emergency Management Agency Emergency Management Institute, 3–2, accessed September 8, 2015, [http://www.training.fema.gov/emiweb/downloads/is-7unit\\_3.pdf](http://www.training.fema.gov/emiweb/downloads/is-7unit_3.pdf).

<sup>259</sup> *Robert T. Stafford Disaster Relief and Emergency Assistance Act* (The Stafford Act) Pub. L. No. 93–288, as amended, 42 U.S.C. 5121 et seq., 1, accessed October 7, 2013, [http://www.fema.gov/media-library-data/1383153669955-21f970b19e8eaa67087b7da9f4af706e/stafford\\_act\\_booklet\\_042213\\_508e.pdf](http://www.fema.gov/media-library-data/1383153669955-21f970b19e8eaa67087b7da9f4af706e/stafford_act_booklet_042213_508e.pdf).

A major disaster declaration is generally declared as a result of a disaster or catastrophic event. As defined in the Stafford Act, a major disaster is

Any natural catastrophe (including any hurricane, tornado, storm, high water, winddriven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act to supplement the efforts and available resources of States, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.<sup>260</sup>

Emergency declarations are issued prior to an event “to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe in any part of the United States.”<sup>261</sup> Fire Emergency Management Grant declarations are issued by either the president or a FEMA regional director to provide assistance for “mitigation, management, and control of any fire on public or private forest land or grassland that threatens such destruction as would constitute a major disaster.”<sup>262</sup>

Three types of federal disaster assistance programs are available if a state receives a major disaster declaration under the Stafford Act: Public Assistance, Individual Assistance, and Hazard Mitigation. The determination of the type of assistance the state receives is based on the extent of the damage and the eligibility of those impacted by the disaster.

Stafford Act declarations are based upon damages that occur during a definitive period of time known as the incident period. This requirement is not identified in the Stafford Act but is defined in 44 CFR §206.32(f):

The time interval during which the disaster-causing incident occurs. No Federal assistance under the [Stafford] Act shall be approved unless the damage or hardship to be alleviated resulted from the disaster-causing

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<sup>260</sup> *Robert T. Stafford Disaster Relief and Emergency Assistance Act*, 2.

<sup>261</sup> *Ibid.*, 1–2.

<sup>262</sup> *Ibid.*, 48.

incident which took place during the incident period or was in anticipation of that incident.<sup>263</sup>

Slow-onset disasters take years to fully materialize. Therefore, determining an incident period for these events is difficult if not impossible to ascertain. This eliminates the eligibility of slow-onset disasters for Stafford Act disaster declarations.

The Stafford Act also authorizes funding for disaster preparedness, response, and pre-disaster mitigation. The Emergency Management Performance Grant (EMPG) is intended to “to provide Federal funds to states to assist state, local, territorial, and tribal governments in preparing for all hazards.”<sup>264</sup> The EMPG program is discussed further in Section E.5 of this chapter. The Pre-disaster Mitigation Grant (PDM) program provides funding to “assist States, territories, Federally-recognized tribes, and local communities in implementing a sustained pre-disaster natural hazard mitigation program.”<sup>265</sup> Mitigation planning, projects and public education for reducing the impacts of future disaster are eligible for PDM funding.

The provisions in the Stafford Act for activities related to preparedness, response, and pre-disaster mitigation can be applied to slow-onset disasters. This is substantiated by a memo issued by the FEMA Deputy Associate Administrator for Mitigation on December 23, 2013. The memo announced “FEMA will fund cost effective hazard mitigation projects that include sea level rise estimates.”<sup>266</sup> This is supported by language in the 2015 Hazard Mitigation Grant Program (HMGP) guidance that recognizes

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<sup>263</sup> Emergency Management and Assistance, 44 CFR §206.32(f) (2002), accessed March 20, 2016, [http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=160791ec48963aecb4ca1dd3b91125a3&ty=HTML&h=L&mc=true&r=SECTION&n=se44.1.206\\_132](http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=160791ec48963aecb4ca1dd3b91125a3&ty=HTML&h=L&mc=true&r=SECTION&n=se44.1.206_132).

<sup>264</sup> “Notice of Funding Opportunity (NOFO): Fiscal Year 2016 Emergency Management Performance Grant Program (EMPG),” U.S. Department of Homeland Security, 2, accessed April 3, 2016, [http://www.fema.gov/media-library-data/1455571902574-a84f5a1b2f450795a70cce1f5ee7b967/FY\\_2016\\_EMPG\\_NOFO\\_FINAL.pdf](http://www.fema.gov/media-library-data/1455571902574-a84f5a1b2f450795a70cce1f5ee7b967/FY_2016_EMPG_NOFO_FINAL.pdf).

<sup>265</sup> “Pre-Disaster Mitigation Grant Program,” U.S. Department of Homeland Security, accessed April 3, 2016, <http://www.fema.gov/pre-disaster-mitigation-grant-program>.

<sup>266</sup> Roy E. White, “Memo on Sea Level Rise and Hazard Mitigation Assistance Programs,” Federal Emergency Management Agency, accessed September 19, 2015, <http://www.fema.gov/media-library-data/1387903153505-99696bdb497c9e03bca73a97f98550e8/HMA%20Sea%20Level%20Rise%20Cover%20Memo%202012-23-13.pdf>.

“Mitigation projects must adapt to new challenges posed by more powerful storms, frequent heavy precipitation, heat waves, prolonged droughts, extreme flooding, higher sea levels, and other weather events.”<sup>267</sup> This language provides the opportunity to use mitigation funding to lessen the impact of drought and sea level rise events. This was clarified further in December 2015 when FEMA released information on eligible climate resilient mitigation activities specifically focused on flood and drought conditions.<sup>268</sup>

## **E. HOMELAND SECURITY ACT**

The Homeland Security Act of 2002 establishes the U.S. Department of Homeland Security and defines the department’s primary mission to:

- A) prevent terrorist attacks within the United States;
- B) reduce the vulnerability of the United States to terrorism;
- C) minimize the damage, and assist in the recovery, from terrorist attacks that do occur within the United States;
- D) carry out all functions of entities transferred to the Department, including by acting as a focal point regarding natural and manmade crises and emergency planning;
- E) ensure that the functions of the agencies and subdivisions within the Department that are not related directly to securing the homeland are not diminished or neglected except by a specific explicit Act of Congress;
- F) ensure that the overall economic security of the United States is not diminished by efforts, activities, and programs aimed at securing the homeland; and
- G) monitor connections between illegal drug trafficking and terrorism, coordinate efforts to sever such connections, and otherwise contribute to efforts to interdict illegal drug trafficking.<sup>269</sup>

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<sup>267</sup> “Hazard Mitigation Guidance: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and Flood Mitigation Assistance Program,” Federal Emergency Management Agency, February 27, 2015, 38, [http://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA\\_Guidance\\_022715\\_508.pdf](http://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf).

<sup>268</sup> “Climate Resilient Mitigation Activities for Hazard Mitigation Assistance,” Federal Emergency Management Agency, accessed April 3, 2016, <https://www.fema.gov/media-library/assets/documents/110202>.

<sup>269</sup> *Homeland Security Act of 2002*, Pub. L. No. 107–296, §101(b) (2002), accessed April 3, 2016, <https://www.gpo.gov/fdsys/pkg/PLAW-107publ296/pdf/PLAW-107publ296.pdf>.

The defining language of the Department of Homeland Security’s mission is primarily focused on counter-terrorism. However, it also identifies the department’s role as a focal point for both “natural and manmade crises and emergency planning.”<sup>270</sup> Therefore, subsequent enabling guidance and assistance to states for prevention, protection, mitigation, response and recovery activities under this act should address both manmade and natural threats, including slow-onset disasters. Figure 12 illustrates enabling guidance and assistance provided by the Homeland Security Act.

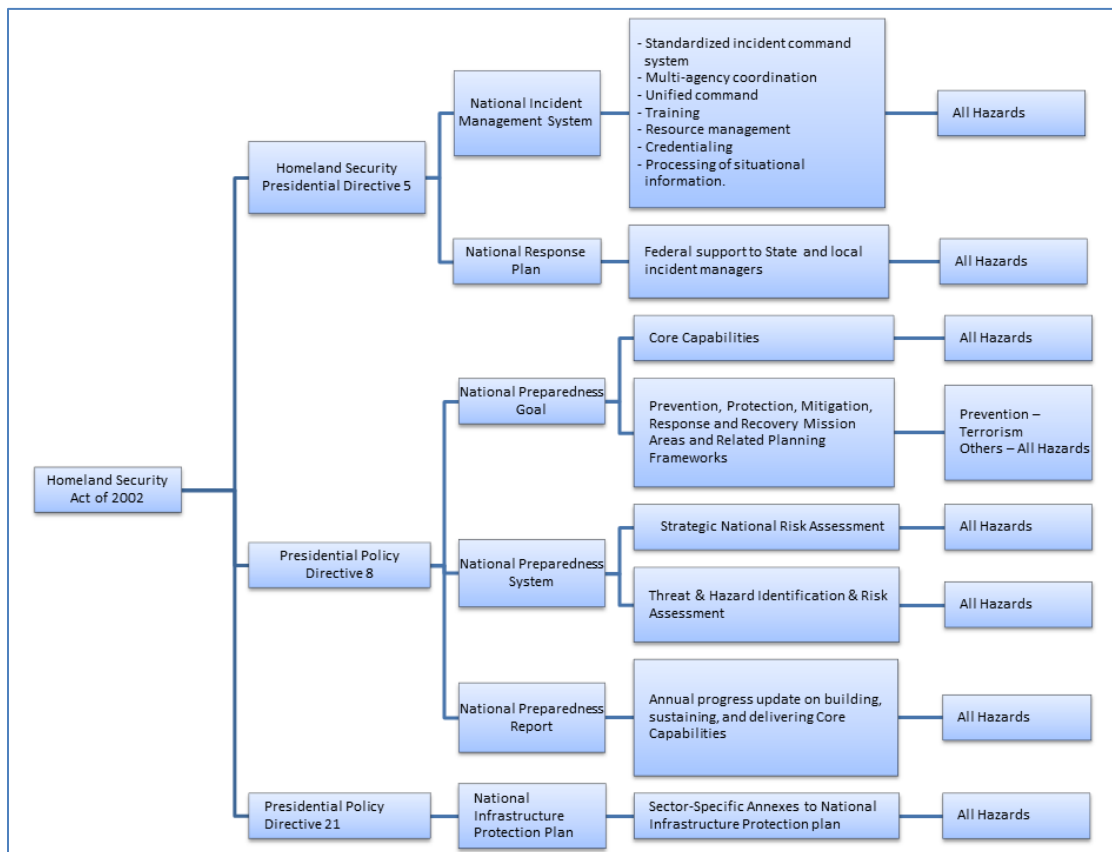


Figure 12. Homeland Security Act: Addressing Natural and Manmade Threats

<sup>270</sup> Homeland Security Act of 2002, Pub. L. No.107-296, §101(b) (2002).



## **1. Homeland Security Presidential Directive 5 (HSPD 5): Management of Domestic Incidents**

The Department of Homeland Security's mission is supported by Homeland Security Presidential Directive 5 (HSPD 5): Management of Domestic Incidents that directs the Secretary of Homeland Security to develop a "consistent nationwide approach for Federal, State, and local governments to work effectively and efficiently together to prepare for, respond to, and recover from domestic incidents, regardless of cause, size, or complexity."<sup>271</sup> This consistent nationwide approach called for in HSPD 5 is achieved with the National Incident Management System (NIMS) that establishes a standardized incident command system, multi-agency coordination, unified command, training, resource management, credentialing, and the processing of situational information. This directive also establishes a National Response Plan (NRP) to "provide the structure and mechanisms for national level policy and operational direction for Federal support to State and local incident managers."<sup>272</sup> The NRP has since been replaced by the National Response Framework. The directives issued under HSPD 5 can be applied to slow-onset disasters.

## **2. Presidential Policy Directive (PPD) 8: National Preparedness and Related Initiatives**

Presidential Policy Directive (PPD) 8: National Preparedness

is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the Nation, including acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters.<sup>273</sup>

The Directive requires the establishment of a National Preparedness Goal, National Preparedness System and National Preparedness Report. The Strategic National Risk

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<sup>271</sup> "Management of Domestic Incidents, Homeland Security Presidential Directive 5," U.S. Department of Homeland Security, February 28, 2003, Item # 15, <http://www.dhs.gov/sites/default/files/publications/Homeland%20Security%20Presidential%20Directive%205.pdf>.

<sup>272</sup> Ibid., Item # 16a.

<sup>273</sup> "National Preparedness, Presidential Policy Directive/PPD-8," U.S. Department of Homeland Security, March 30, 2011, accessed December 10, 2014, <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>.

Assessment and National Planning Frameworks are additional initiatives that support National Preparedness. The directives issued under PPD8 can be applied to slow-onset disasters.

**a.      *National Preparedness Goal***

The National Preparedness Goal is to achieve “a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk.”<sup>274</sup> Thirty-one core capabilities were identified with the release of the goal as the “distinct critical elements necessary for our success.”<sup>275</sup> These are grouped under the Prevention, Protection, Mitigation, Response and Recovery mission areas.<sup>276</sup> Four of the mission areas are intended to address all hazards, while prevention addresses the “capabilities necessary to avoid, prevent or stop a threatened or actual act of terrorism.”<sup>277</sup>

**b.      *National Preparedness System***

The National Preparedness System is comprised of six components:

- (1)    Identifying and Assessing Risk
- (2)    Estimating Capability Requirements
- (3)    Building and Sustaining Capabilities
- (4)    Planning to Deliver Capabilities

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<sup>274</sup> “National Preparedness Goal,” 2<sup>nd</sup> ed., U.S. Department of Homeland Security, September 2015, [http://www.fema.gov/media-library-data/1443799615171-2aae90be55041740f97e8532fc680d40/National\\_Preparedness\\_Goal\\_2nd\\_Edition.pdf](http://www.fema.gov/media-library-data/1443799615171-2aae90be55041740f97e8532fc680d40/National_Preparedness_Goal_2nd_Edition.pdf).

<sup>275</sup> Ibid.

<sup>276</sup> “Mission Areas,” Federal Emergency Management Agency, accessed September 10, 2015. <http://www.fema.gov/mission-areas>.

<sup>277</sup> Ibid.

- (5) Validating Capabilities
- (6) Reviewing and Updating<sup>278</sup>

The Threat and Hazard Identification and Risk Assessment (THIRA) is used to identify risks and assess threats and consequences faced by each community. The Strategic National Risk Assessment is used to analyze the greatest risks to the nation. Together these create an integrated understanding of the range of threats and hazards that would stress the core capabilities of the nation.<sup>279</sup> Risks identified in a THIRA can include slow-onset disasters.

***c. National Preparedness Report***

The annual National Preparedness Report provides an update on the nation's progress in building, sustaining, and delivering the 31 Core Capabilities identified in the National Preparedness Goal. One finding from the 2015 National Preparedness Report is relevant to the subject of this thesis as it refers to the 2012 and 2013 national droughts as an example of the complex events cited below:

In recent years, several events that have not resulted in a Stafford Act declaration have required extensive Federal interagency coordination in support of state and local response efforts. These complex events have taken place over extended periods of time and often across large geographic areas, with uncertainty surrounding the role of existing coordination structures and authorities for multi-agency activity for non-Stafford Act events.<sup>280</sup>

***d. Strategic National Risk Assessment***

The Strategic National Risk Assessment was performed to recognize the core capabilities for “strengthening the security and resilience of the United States through systematic preparation for threats that pose the greatest risk to the security of the Nation,

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<sup>278</sup> “National Preparedness System,” U.S. Department of Homeland Security, November 2011, 1, [http://www.fema.gov/media-library-data/20130726-1855-25045-8110/national\\_preparedness\\_system\\_final.pdf](http://www.fema.gov/media-library-data/20130726-1855-25045-8110/national_preparedness_system_final.pdf).

<sup>279</sup> *Ibid.*, 1–2.

<sup>280</sup> “2015 National Preparedness Report,” U.S. Department of Homeland Security, 12, accessed September 10, 2015. [http://www.fema.gov/media-library-data/1432751954859-fcaf2acc365b5a7213a38bbeb5cd1d61/2015\\_NPR\\_508c\\_20150527\\_Final.pdf](http://www.fema.gov/media-library-data/1432751954859-fcaf2acc365b5a7213a38bbeb5cd1d61/2015_NPR_508c_20150527_Final.pdf).

including acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters.”<sup>281</sup> The assessment identifies national-level events for assessment. These are grouped into three categories: 1) natural hazards; 2) technological or accidental hazards; and 3) adversarial, human-caused threats or hazards.

Thresholds of consequences are used to determine whether or not events should be considered for assessment. The thresholds include economic consequences and fatalities or injuries/illnesses. Events are limited to those having a “distinct beginning and end and those with an explicit nexus to homeland security missions.”<sup>282</sup> In some cases, events are considered if it is believed the psychological impact of an occurrence would rise to the level of a national incident. Once identified, risks are assessed based on their frequency and consequences relative to six categories of harm: 1) loss of life; 2) injuries and illnesses; 3) direct economic costs; 4) social displacement; 5) psychological distress; and 6) environment impact.

Slow-onset disasters are natural disasters that have an explicit nexus to the homeland security mission areas of Protection, Mitigation, Response and Recovery. The results of my research in Chapter II also shows slow-onset disasters would qualify for assessment as natural hazards that have economic consequences, results in fatalities, and causes damages identified in the six categories of harm. However, slow-onset disasters and their consequences take years to fully emerge. Consequently, they cannot be considered in the Strategic National Risk Assessment due to the limiting factor of not having a distinct beginning and end. However, The SNRA does acknowledge drought and heat waves among other threats to be considered in preparedness planning:

Threats and hazards, such as droughts, heat waves, winter storms, rain storms, and different types of technological/accidental or human-caused hazards, can also pose a risk to jurisdictions across the country and should be considered, as appropriate, in preparedness planning.<sup>283</sup>

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<sup>281</sup> “National Strategic Risk Assessment,” Federal Emergency Management Agency, 1, accessed November 8, 2014, [http://www.fema.gov/media-library-data/20130726-1854-25045-5035/rma\\_strategic\\_national\\_risk\\_assessment\\_ppd8\\_1\\_.pdf](http://www.fema.gov/media-library-data/20130726-1854-25045-5035/rma_strategic_national_risk_assessment_ppd8_1_.pdf).

<sup>282</sup> Ibid., 2.

<sup>283</sup> Ibid., 1.

### **3. National Planning Frameworks**

The National Planning Frameworks “set the strategy and doctrine for building, sustaining, and delivering the core capabilities identified in the National Preparedness Goal.”<sup>284</sup> There are five frameworks. Each concentrates on one of the key mission areas of prevention, protection, mitigation, response, and recovery. The National Prevention Framework specifically addresses terrorism and provides information on what to do “upon the discovery of intelligence or information regarding an imminent threat to the homeland in order to thwart an initial or follow-up terrorist act.”<sup>285</sup> The remaining frameworks have a nexus to both terrorism and natural disasters and can be applied to slow-onset disasters.

### **4. Critical Infrastructure Policy Directives, National Infrastructure Protection Plan and Sector-Specific Plans**

As discussed in Chapter III, the protection of the nation’s critical infrastructure is of great importance to our national security. Federal strategies and policies to guide protection efforts began with the formation of the President’s Commission on Critical Infrastructure Protection in 1996. The Commission’s findings and recommendations led to the issuance of Presidential Decision Directive 63: Critical Infrastructure Protection (PDD 63) that “set as a national goal the ability to protect the nation’s critical infrastructure from intentional attacks (both physical and cyber) by the year 2003.”<sup>286</sup> Since that time, a number of directives and strategies were issued to further this goal. Most notably are the National Strategy for Homeland Security in 2002, Homeland Security Presidential Directive 7 (HSPD 7): Critical Infrastructure Identification, Prioritization, and Protection, December 2003 and Presidential Policy Directive 21: Critical Infrastructure Security and Resilience, February 2013. Cumulatively, these policies establish the framework for addressing critical infrastructure protection:

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<sup>284</sup> “Overview of the National Planning Frameworks,” U.S. Department of Homeland Security, July 2014, 1, [http://www.fema.gov/media-library-data/1406718145199-838ef5bed6355171a1f2d934c25f8ad0/FINAL\\_Overview\\_of\\_National\\_Planning\\_Frameworks\\_20140729.pdf](http://www.fema.gov/media-library-data/1406718145199-838ef5bed6355171a1f2d934c25f8ad0/FINAL_Overview_of_National_Planning_Frameworks_20140729.pdf).

<sup>285</sup> *Ibid.*, 2.

<sup>286</sup> John D. Moteff, *Critical Infrastructures: Background, Policy and Implementation* (CRS Report No. RL30153) (Washington, DC: Congressional Research Service) June 10, 2015, 4, <http://fas.org/sgp/crs/homesecc/RL30153.pdf>.

identification of critical infrastructure sectors; ensuring physical and cyber security; public-private partnerships; national infrastructure protection plan and “sector-specific plans to establish goals and priorities for the sector that address their current risk environment.”<sup>287</sup> Climate change is specifically identified within the risk environment to be addressed.<sup>288</sup>

## **5. Federal Preparedness (Non-disaster) Grants**

The Department of Homeland Security provides preparedness non-disaster grants to “improve the nation’s readiness in preventing, protecting against, responding to, recovering from and mitigating terrorist attacks, major disasters and other emergencies.”<sup>289</sup> These programs are authorized by varying legislation but funding for all are appropriated through the annual Department of Homeland Security Appropriations Act.

The Emergency Management Performance Grant program (EMPG) is authorized under the Stafford Act. It is intended to “obtain the resources required to support the National Preparedness Goal’s (the Goal’s) associated mission areas and core capabilities.”<sup>290</sup> Funding under this grant may be used for personnel, planning, training, equipment, and facilities to address all hazards.

The Homeland Security Grant Program (HSGP) is comprised of the State Homeland Security Program (SHSP), Urban Area Security Initiative (UASI), and Operation Stonegarden (OPSG). Together these are intended “to support state and local efforts to prevent terrorism and other catastrophic events and to prepare the nation for the

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<sup>287</sup> “2015 Sector-Specific Plans,” U.S. Department of Homeland Security, accessed May 3, 2016, <https://www.dhs.gov/2015-sector-specific-plans#>.

<sup>288</sup> Ibid.

<sup>289</sup> “DHS Announces Grant Allocations for Fiscal Year (FY) 2016 Preparedness Grants,” U.S. Department of Homeland Security, press release dated February 16, 2016, accessed May 3, 2016, <https://www.dhs.gov/news/2016/02/16/dhs-announces-funding-opportunity-fiscal-year-fy-2016-preparedness-grants>.

<sup>290</sup> “Notice of Funding Opportunity (NOFO): Fiscal Year 2016 Emergency Management Performance Grant Program (EMPG),” U.S. Department of Homeland Security, 2.

threats and hazards that pose the greatest risk to the security of the United States.”<sup>291</sup> However, eligibility is further limited in the specific grant guidance for each component. For SHSP, funding is allowable for “preparedness activities that address high-priority preparedness gaps across all core capabilities where a nexus to terrorism exists.”<sup>292</sup> The UASI grant is limited to “efforts to build, sustain, and deliver the capabilities necessary to prevent, protect against, mitigate, respond to, and recover from acts of terrorism.”<sup>293</sup> Finally, OPSG funding is intended to “to secure the United States’ borders along routes of ingress from international borders.”<sup>294</sup> Effectively, these programs exclude funding for activities related to slow-onset disasters even when considered as *other threats*.

The remaining 2016 preparedness non disaster grants—Tribal Homeland Security Grant Program (THSGP), Non-Profit Security Grant Program (NSGP), Port Security Grant Program (PSGP), Intercity Passenger Rail–AMTRAK (IPR) Program, Transit Security Grant Program (TSGP), and Intercity Bus Security Grant Program (IBSGP)—also include language that limits funding eligibility to terrorism related activities.<sup>295</sup> Figure 13 illustrates the FY 2016 Federal Preparedness Grants.

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<sup>291</sup> “Notice of Funding Opportunity, Fiscal Year 2016 Homeland Security Grant Program (HSGP),” U.S. Department of Homeland Security, 2, accessed April 23, 2016, [http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY\\_2016\\_HSGP\\_NOFO\\_FINAL.pdf](http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY_2016_HSGP_NOFO_FINAL.pdf).

<sup>292</sup> *Ibid.*, 2.

<sup>293</sup> *Ibid.*

<sup>294</sup> *Ibid.*

<sup>295</sup> The Notice of Funding Opportunity containing the guidelines for each of these grants can be accessed by following the links provided on FEMA’s “Preparedness (Non-Disaster) Grants” site, <http://www.fema.gov/preparedness-non-disaster-grants>.

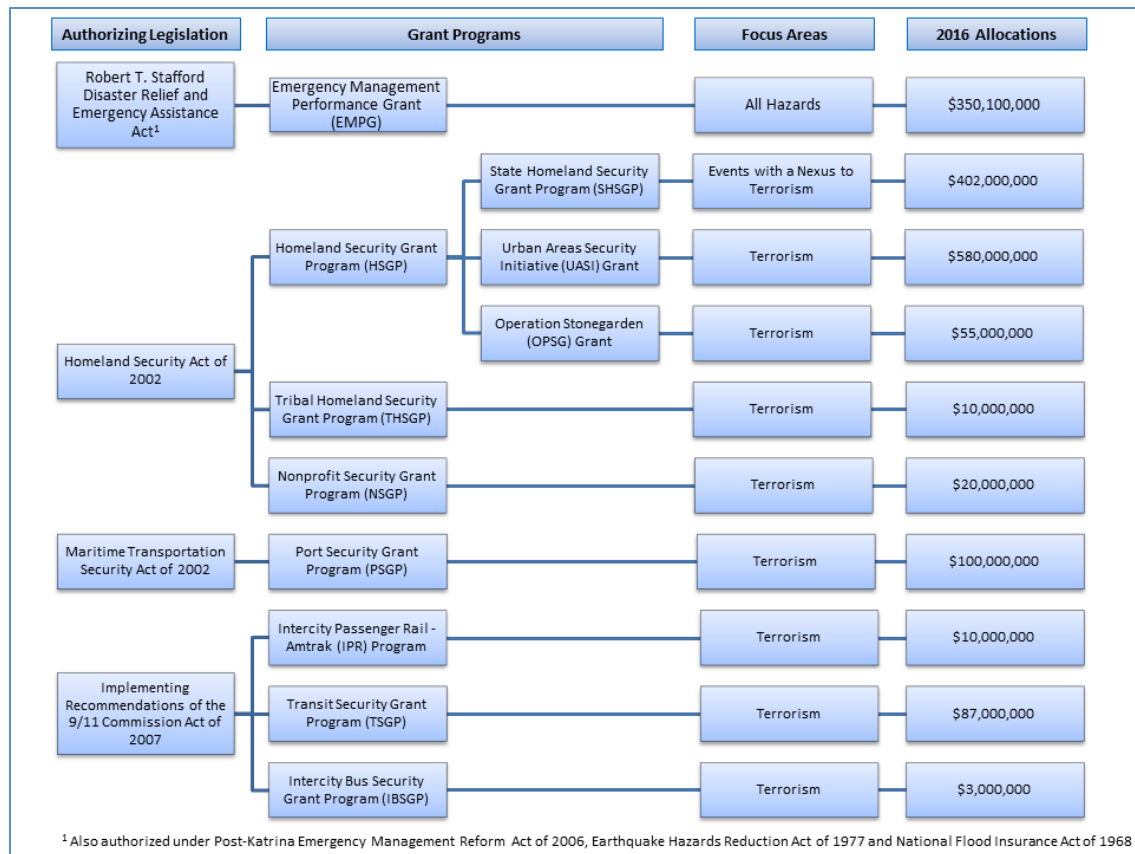


Figure 13. 2016 Federal Preparedness Grants: Authorization, Focus Areas and Allocations

The 2015 National Security Strategy states: “Climate change is an urgent and growing threat to our national security, contributing to increased natural disasters, refugee flows, and conflicts over basic resources like food and water.”<sup>296</sup> However, activities related to an *increase in natural disasters* are eligible for only \$350.1 million or 22 percent of the \$1.6 billion allocated for Fiscal Year 2016 Federal Preparedness (Non-Disaster) Grants. This disparity in funding creates a challenge for state, local, and tribal jurisdictions when prioritizing between activities related to terrorism and naturally occurring events such as slow-onset disasters.

<sup>296</sup> “National Security Strategy,” The White House, February 2015, 12, [https://www.whitehouse.gov/sites/default/files/docs/2015\\_national\\_security\\_strategy.pdf](https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf).



## **F. MOVING FORWARD: EMERGING INITIATIVES FOR ADDRESSING SLOW-ONSET DISASTERS**

Homeland security is defined as “a concerted national effort to ensure a homeland that is safe, secure, and resilient against terrorism and other hazards where American interests, aspirations, and way of life can thrive.”<sup>297</sup> The nation’s coordinated approach to homeland security supports this effort through enabling legislations, policies and programs. Many of these cannot be applied to slow-onset disasters because of the limiting factors of a definitive incident period or an explicit nexus to terrorism. However, recent initiatives indicate that changes to this approach are occurring.

### **1. Strategic Foresight Initiative**

The Strategic Foresight Initiative (SFI) was launched in 2011 by FEMA as a collaborative strategic planning effort within the emergency management community. The initiative identifies nine drivers for change that are “likely to affect the field of emergency management significantly over the next 15 years.”<sup>298</sup> It is recommended that these drivers be “considered as the emergency management community makes long-term plans and decisions.”<sup>299</sup> The identified drivers are “Changing role of the individual in society, climate change, critical infrastructure, the evolving terrorist threat, global interdependencies, government budgets, technological innovation and dependence, universal access to and use of information, and U.S. demographic shifts.”<sup>300</sup> Figure 14 illustrates the interconnectedness of the identified drivers for change.

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<sup>297</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U.S. Department of Homeland Security, 13.

<sup>298</sup> “Strategic Foresight Initiative: Summary of Findings,” Federal Emergency Management Agency, 1, accessed October 4, 2015, [http://www.fema.gov/media-library-data/20130726-1836-25045-4146/findings\\_051111.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-4146/findings_051111.pdf).

<sup>299</sup> Ibid.

<sup>300</sup> Ibid.

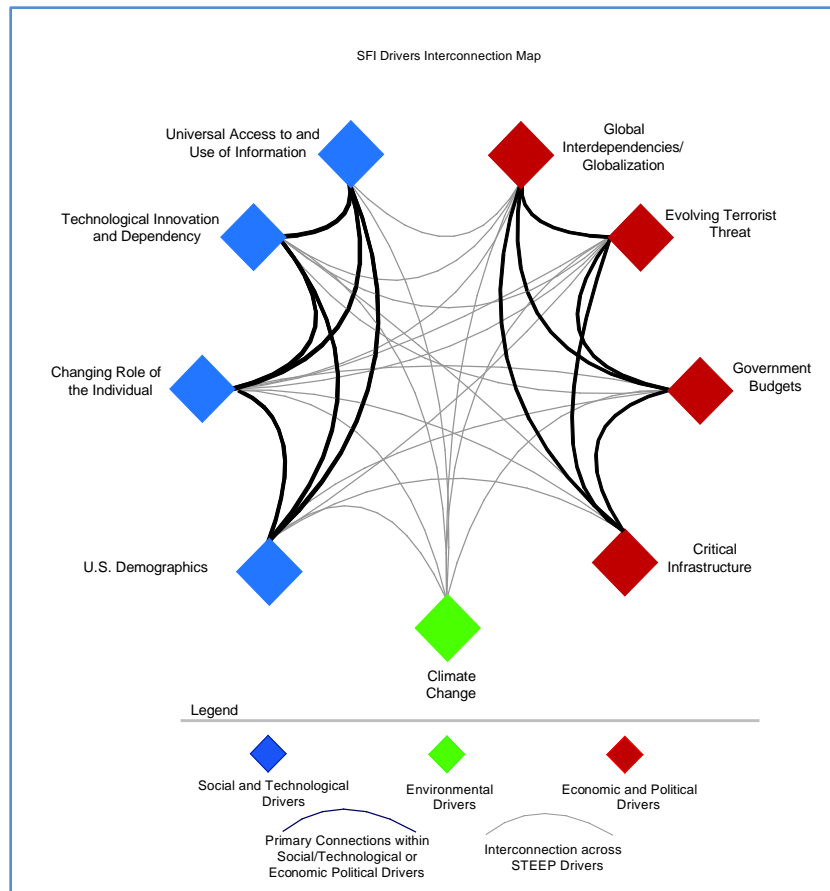


Figure 14. SFI Drivers Interconnection Map<sup>301</sup>

Climate change is the only force for change identified as an Environmental Driver. Ocean acidification, melting Arctic ice, sea-level rise, and drought are identified as a subset of climate change. Therefore, only the correlations between slow-onset disasters and their specific impact to the Social and Technological; and Economic and Political Drivers are discussed in this chapter.

#### *a. Social and Technological Drivers*

The Social and Technological Drivers are comprised of U.S. Demographic Shifts, Changing Role of the Individual, Technological Innovation and Dependency, and

<sup>301</sup> Adapted from "Crisis Response and Disaster Resilience 2030: Forging Strategic Action in an Age of Uncertainty, Progress Report Highlighting the 2010–2011 Insights of the Strategic Foresight Initiative," Federal Emergency Management Agency, Strategic Foresight Initiative, January 2012, 6, [http://www.fema.gov/media-library-data/20130726-1816-25045-5167/sfi\\_report\\_13.jan.2012\\_final.docx.pdf](http://www.fema.gov/media-library-data/20130726-1816-25045-5167/sfi_report_13.jan.2012_final.docx.pdf).

Universal Access to Use of Information. The growing number of the elderly, racially and ethnically diverse populations, economic and population growth in metropolitan and coastal communities are factors that contribute to the U.S. Demographics Shift driver.<sup>302</sup>

Continued population growth in coastal communities will increase development of areas that are at risk for flooding caused by sea level rise.<sup>303</sup> Emergency managers may be faced with changes in the size of their local population due to mass migrations into or out of their jurisdictions as a result of drought or coastal flooding. This could also be exacerbated by increasingly severe weather in some geographic areas as a result of melting Arctic ice's impact on the North American jet stream.<sup>304</sup> An inflow of people from mass migration can quickly deplete emergency resources for response and recovery activities as during the Dust Bowl.<sup>305</sup> Conversely, the outflow of population impacts a community's tax base and can drastically reduce local funding for emergency services.

Technology has brought about changes in the way individuals interact. As presented in the *Changing Role of the Individual* paper, "Americans are increasingly relating to one another in different ways, particularly through online forums."<sup>306</sup> This is supported by a Pew Research Center report which found "nearly two-thirds of American adults (65 percent) use social networking sites, up from 7 percent when Pew Research Center began systematically tracking social media usage in 2005."<sup>307</sup> As a result, there is

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<sup>302</sup> U.S. Demographic Shifts: Long-term Trends and Drivers and Their Implications for Emergency Management, "Federal Emergency Management Agency, Strategic Foresight Initiative," accessed October 4, 2015, [http://www.fema.gov/media-library-data/20130726-1836-25045-7108/demography\\_paper\\_051011.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-7108/demography_paper_051011.pdf).

<sup>303</sup> Jerry M. Melillo, *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*, 88.

<sup>304</sup> Jeffrey P. Donnelly, et al., "Climate Forcing of Unprecedented Intense Hurricane Activity in the Last 2000 Years," 49–65.

<sup>305</sup> "Drought in the Dust Bowl Years," University of Nebraska-Lincoln, National Drought Mitigation Center."

<sup>306</sup> "Changing Role of the Individual: Long-term Trends and Drivers and Their Implications for Emergency Management," Federal Emergency Management Agency, Strategic Foresight Initiative, August 2011, accessed September 29, 2015, [http://www.fema.gov/media-library-data/1402509850071-ecde32290a64f87e5a0a6fb4d3edf777/DISCLAIMERChanging%20Role%20of%20the%20Individual%20080311\\_508.pdf](http://www.fema.gov/media-library-data/1402509850071-ecde32290a64f87e5a0a6fb4d3edf777/DISCLAIMERChanging%20Role%20of%20the%20Individual%20080311_508.pdf).

<sup>307</sup> Andrew Perrin, "Social Media Usage: 2005–2015," Pew Research Center, October 8, 2015, accessed October 10, 2015, <http://www.pewinternet.org/2015/10/08/social-networking-usage-2005-2015/>.

a growing trend for public safety professionals to use social media for the delivery of emergency notifications and public information. Conversely, these same systems can be used to gather information on disaster conditions in impacted areas—a method known as crowdsourcing.<sup>308</sup> The *Universal Access to and Use of Information* paper cautions the use of crowdsourced information because “problems can arise as a result of inaccurate and/or unreliable information provided by internet sources. Terrorists or other mischievous individuals may post or send false messages.”<sup>309</sup>

Social networking relies on technology that is highly vulnerable to failure during emergency and non-emergency high-visibility events. This will create additional challenges as indicated in the *Technological Development and Dependency* paper that states, “the reliance on technology may also make infrastructure more vulnerable to cyber attacks, natural disasters, Electromagnetic Pulse events and solar flares. These types of events can knock out the power grid and disable electric/electronic devices.”<sup>310</sup>

**b. Economic and Political Drivers**

The Economic and Political Drivers are comprised of Critical Infrastructure, Government Budgets, Evolving Terrorist Threat, and Global Interdependencies. The increasing age of infrastructure in the United States is a significant threat because of the number of deficiencies identified in recent years. A report by the American Society of Civil Engineers gave the nation’s infrastructure a grade of D+, which falls between mediocre and poor. The report also projects an investment of \$3.6 trillion by 2020 is

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<sup>308</sup> *Merriam-Webster Online Dictionary* s.v. “crowdsourcing”: “the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers,” accessed October 10, 2015, <http://www.merriam-webster.com/dictionary/crowdsourcing>.

<sup>309</sup> “Access to and Use of Information: Long-term Trends and Drivers and Their Implications for Emergency Management,” Federal Emergency Management Agency, Strategic Foresight Initiative, Universal 3, accessed October 4, 2015, [http://www.fema.gov/media-library-data/20130726-1836-25045-5549/universal\\_access\\_paper\\_051011.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-5549/universal_access_paper_051011.pdf).

<sup>310</sup> “Technological Development and Dependency: Long-term Trends and Drivers and Their Implications for Emergency Management,” Federal Emergency Management Agency, Strategic Foresight Initiative, 4, accessed October 4, 2015, [http://www.fema.gov/media-library-data/20130726-1836-25045-2988/technology\\_dev\\_\\_paper.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-2988/technology_dev__paper.pdf).

needed to remedy this situation.<sup>311</sup> The supporting data for the report includes deficiencies in the levees, bridges, dams, roads, transit, and energy sectors. In addition, the 2013 National Infrastructure Protection Plan (NIPP) states:

The effects of extreme weather pose a significant risk to critical infrastructure—rising sea levels, more severe storms, extreme and prolonged drought conditions, and severe flooding combine to threaten infrastructure that provides essential services to the American public. Ongoing and future changes to the climate have the potential to compound these risks and could have a major impact on infrastructure operations.<sup>312</sup>

The collapse of bridges, roads, and transportation systems will severely compromise successful efforts for mass evacuations from disaster areas. Additionally, the growing dependence of the population on the use of technology for emergency communications requires sustained efforts to ensure its availability during disasters. Overall, the implication for emergency management is that “without reliable infrastructure in place, protection, response and recovery operations may suffer.”<sup>313</sup>

## **2. Federal Climate Change Projects**

The Obama Administration has undertaken a number of actions that indicate the federal government is re-evaluating its approach to climate change and by extension, slow-onset disasters. One is *Executive Order 13653—Preparing the United States for the Impacts of Climate Change* that

instructs agencies to modernize Federal programs to support climate-resilient investments, plan for climate change related risks to Federal facilities, operations, and programs, and provide the information, data, and tools that state, local, and private-sector leaders need to make smart decisions to improve preparedness and resilience.<sup>314</sup>

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<sup>311</sup> “2013 Report Card for America’s Infrastructure,” American Society of Civil Engineers, accessed October 10, 2015, <http://www.infrastructurereportcard.org/a/#p/home>.

<sup>312</sup> “NIPP 2013: Partnering for Critical Infrastructure Security and Resilience,” U.S. Department of Homeland Security, 8.

<sup>313</sup> “Crisis Response and Disaster Resilience 2030,” Federal Emergency Management Agency, Strategic Foresight Initiative, 10.

<sup>314</sup> “Climate Change Resilience,” The White House, Council on Environmental Quality, accessed January 1, 2014, <https://www.whitehouse.gov/administration/eop/ceq/initiatives/resilience>.

This Executive Order could be applied to the shortfalls identified in homeland security policies to address slow-onset disasters—a defined incident period and an implicit nexus to terrorism. It orders Federal agencies to

- (i) identify and seek to remove or reform barriers that discourage investments or other actions to increase the Nation’s resilience to climate change while ensuring continued protection of public health and the environment;
- (ii) reform policies and Federal funding programs that may, perhaps unintentionally, increase the vulnerability of natural or built systems, economic sectors, natural resources, or communities to climate change related risks;
- (iii) identify opportunities to support and encourage smarter, more climate-resilient investments by States, local communities, and tribes, including by providing incentives through agency guidance, grants, technical assistance, performance measures, safety considerations, and other programs.<sup>315</sup>

## **G. CONCLUSION**

This chapter provides an overview of the nation’s coordinated approach to homeland security and whether or not it adequately addresses slow-onset disasters. I found that some aspects of this approach can be applied to slow-onset disasters while others cannot. Federal legislation, programs, and funding provide critical resources to supplement the efforts of state, local, and tribal jurisdictions to achieve the National Preparedness Goal and National Security Strategy. However, fully utilizing these resources to address slow-onset disasters is challenging.

The Code of Federal Regulations stipulates that “no Federal assistance under the [Stafford] Act shall be approved unless the damage or hardship to be alleviated resulted from the disaster-causing incident which took place during the incident period or was in anticipation of that incident.”<sup>316</sup> Events that are assessed in the Strategic National Risk Assessment have a “distinct beginning and end.”<sup>317</sup> Further, all but one of the Federal

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<sup>315</sup> Exec. Order No. 13653 (2013).

<sup>316</sup> Emergency Management and Assistance, 44 C.F.R. 206.32 (2002). .

<sup>317</sup> “National Strategic Risk Assessment,” Federal Emergency Management Agency, 2.

Preparedness (Non-Disaster) Grant Programs limit funding eligibility to activities “where a nexus to terrorism exists.”<sup>318</sup>

However, FEMA’s Strategic Foresight Initiative and President Obama’s climate change initiatives indicate that slow-onset disasters may yet receive recognition as a subset of climate change warranting further attention. The Strategic Foresight Initiative has found “the emergency management community may be required to reevaluate how services are provided to accommodate the potentially hazardous impacts of climate change, and implement comprehensive changes to strategic plans.”<sup>319</sup> While Executive Order 13653 opens the door for Federal agencies to “modernize Federal programs to support climate-resilient investments.”<sup>320</sup>

My research reveals that the coordinated approach to homeland security contains some internal contradictions. For example, the definition of homeland security calls for ensuring a homeland that is “safe, secure, and resilient against terrorism and other hazards where American interests, aspirations, and way of life can thrive.”<sup>321</sup> However, our policies and programs predominantly do not address slow-onset disasters as other hazards that threaten our interests, aspirations, or way of life. The next chapter presents my research conducted to gain an understanding of how this dichotomy in the framing of our nation’s coordinated approach to homeland security could occur.

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<sup>318</sup> “Notice of Funding Opportunity, Fiscal Year 2016 Homeland Security Grant Program (HSGP),” United States Department of Homeland Security, 2.

<sup>319</sup> “Climate Change: Long-term Trends and Drivers and Their Implications for Emergency Management,” Federal Emergency Management Agency, Strategic Foresight Initiative, August 2011, 3, [http://www.fema.gov/media-library-data/20130726-1836-25045-2700/climate\\_change\\_paper.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-2700/climate_change_paper.pdf).

<sup>320</sup> “Climate Change Resilience,” The White House, Council on Environmental Quality.

<sup>321</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U. S. Department of Homeland Security, 13.

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## VI. THE FRAMING OF HOMELAND SECURITY POLICIES

There is a time when we must firmly choose the course we will follow, or the relentless drift of events will make the decision for us.

—Herbert V. Prochnow

### A. INTRODUCTION

This chapter submits the findings of research to gain an understanding of underlying factors that drive the genesis of homeland security policies and how these could result in contradictions the nation's approach to homeland security. The frameworks of three experts in the field of homeland security—Kathleen Tierney, Claire Rubin and Donald Kettl—were chosen for this undertaking because their work is widely known in the homeland security discipline and has been cited in numerous research papers and other publications.

### B. IDENTIFYING MAJOR FOCUSING EVENTS FOR CHANGE

In her introduction to the book *Emergency Management: The American Experience, 1900–2010*, Claire Rubin puts forth the concept that “changes in emergency management policies, processes, and authority are event driven. Therefore, major focusing events provide an opportunity to explore their effects on emergency management principles and practices.”<sup>322</sup> The works of the authors in this book provide a historical perspective that verifies Rubin's argument that major focusing events influence disaster management practices and policies. According to Rubin, these major focusing events share some or all of the characteristics of magnitude, high visibility, unusual location, high impact, unique threat agent, surprise, and eligibility for disaster declaration.<sup>323</sup>

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<sup>322</sup> Claire B. Rubin, “Introduction: 110 Years of Disaster Response in and Emergency Management in the United States” in *Emergency Management: The American Experience, 1900–2010*, 2nd ed. Claire B. Rubin (Boca Raton, FL: CRC Press, 2012), 4, Kindle edition.

<sup>323</sup> Ibid.

Magnitude is described as an occurrence that affects a large geographic area or large number of people. Events such as 9/11, Hurricanes Katrina and Sandy; and the 2011 Japan tsunami are considered having high visibility as they received extensive media coverage; captured the attention of a large audience; and have left a lasting impression on the public. Unusual location refers to an event occurring in an area that is not normally associated with a specific disaster. High-impact events cause damages that have widespread and long-term consequences to the physical, economic, environmental, social, and political structures of a community. The use of commercial airplanes as weapons during the 9/11 World Trade Center and Pentagon attacks is an example of a unique threat agent. Surprise, as explained in Rubin's book, "is often defined as unprecedented."<sup>324</sup> Eligibility for disaster declarations refers to whether or not a disaster can meet the federal threshold for receiving disaster assistance.

The contributions of the authors in Rubin's book support her claim that "virtually all major federal laws, executive directives, programs, policies, organizational changes, and response systems have resulted from major and catastrophic disasters."<sup>325</sup> However, if this was the only framework employed then it would stand that every major and catastrophic disaster would generate changes to homeland security practices and policies. But historically that has not been the case.

### **C. THE PRINCIPLES OF THE KNOWN, UNKNOWN AND SYSTEMS UNDER STRESS**

Donald Kettl argues in *System Under Stress: The Challenge to 21<sup>st</sup> Century Governance* that changes to political systems happen as a result of the occurrences of known and unknown threats and the policy systems reaction to the stress caused by these events.<sup>326</sup> He proposes that "we get warnings but too often fail to react; we learn lessons

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<sup>324</sup> Claire B. Rubin, "Introduction: 110 Years of Disaster Response in and Emergency Management in the United States," 4–5.

<sup>325</sup> Ibid., 6–7.

<sup>326</sup> Donald F. Kettl, *System Under Stress: The Challenge to 21st Century Governance* (Thousand Oaks, CA: CQ Press, SAGE Publications, Ltd., 2014), Kindle edition

from previous disasters but fail to prepare.”<sup>327</sup> As an explanation for this behavior, he begins by quoting Donald Rumsfeld:

As we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don’t know we don’t know. And if one looks throughout the history of our country and other free countries, it is the latter category that tends to be the difficult ones.<sup>328</sup>

Kettl then goes on to explain that “bureaucracies are created to deal with known knowns.”<sup>329</sup> Bureaucracies can also be proficient at addressing known unknowns and he uses the homeland security discipline’s mitigation and response activities as examples of this capability. Communities engage in mitigation activities to reduce the consequences of a known threat although the precise location of the impact is unknown. Response capabilities are developed using the same principle. However, in the case of the unknown unknowns—addressing the unexpected—governments tend not to be as successful.

Governments’ inability to anticipate the occurrence of an unknown unknown results in “policy lightning—what happens when lightning-strike events blow policy off course.”<sup>330</sup> Kettl cites the BP oil spill as an example of a policy lightning event. The government was caught off-guard because “policy was that oil platforms shouldn’t blow up, and that private industry was responsible for following carefully prescribed steps and installing sophisticated equipment to prevent that from happening.”<sup>331</sup> In the case of Hurricane Katrina, government officials had strong indicators that such a catastrophic event could occur. In support of this, Kettl states “it was the worst-case fear of longtime emergency planners—precisely the storm FEMA planners had worried about in 2001 and for which they had conducted major exercises just the year before.”<sup>332</sup> Given these circumstances, Hurricane Katrina was a known unknown rather than an unknown

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<sup>327</sup> Donald F. Kettl, *System Under Stress: The Challenge to 21<sup>st</sup> Century Governance*, location 191.

<sup>328</sup> *Ibid.*, location 223.

<sup>329</sup> *Ibid.*, location 216–227.

<sup>330</sup> *Ibid.*, location 218.

<sup>331</sup> *Ibid.*, location 214.

<sup>332</sup> *Ibid.*, location 431.

unknown and government officials should have been better prepared. Then why was more not done ahead of time to reduce the impacts?

Kettl explains this by identifying three issues: 1) there is the problem of collecting enough information to make reasoned judgments; 2) there is the risk of backsliding; and 3) there is calibrating risk—the way people perceive risk.<sup>333</sup> In practice, these factors can result in government officials operating on “shared lore or on anecdotal experience,”<sup>334</sup> while the public “tend[s] to exaggerate some short-term risks and ignore longer-term threats.”<sup>335</sup> This is often exacerbated by the public’s tendency to vow to make sure big problems that happen do not recur, but we “don’t remember them long enough to follow through.”<sup>336</sup>

With these counterproductive inclinations, how are policies eventually changed? Kettl contends that changes occur as a result of stresses to the policy system. “There is a natural tendency toward backsliding—toward resuming the previous equilibrium. When big stresses jar the system, it is never likely to retreat back completely to where it was, but neither can it maintain a laserlike focus on a single issue.”<sup>337</sup>

#### **D. THE SOCIAL DIMENSIONS OF RISK PERCEPTION**

Kathleen Tierney focuses on the social dimensions of risk perception that encourage or discourage policy development in her book *The Social Roots of Risk: Producing Disasters, Promoting Resilience*.<sup>338</sup> In this book, Tierney takes the standpoint that causes of disasters and the perception of risks are constructs of the social order and therefore, “societies, communities, and organizations have the power to reduce risk and

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<sup>333</sup> Donald F. Kettl, *System Under Stress: The Challenge to 21<sup>st</sup> Century Governance*, location 2144–2165.

<sup>334</sup> *Ibid.*, location 2177.

<sup>335</sup> *Ibid.*

<sup>336</sup> *Ibid.*, location 3054.

<sup>337</sup> *Ibid.*, location 3296.

<sup>338</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience* (Stanford, CA: Stanford University Press, 2014), location 182, Kindle edition.

become more resilient.”<sup>339</sup> However, she also proposes that despite having this ability people “completely overlook the possibility of statistical ‘outliers’ or rare events that have large impacts.”<sup>340</sup> According to Tierney, this “stems from the simple and entirely understandable fact that perceptions, frames, and social constructions of the world are strongly shaped by past experience.”<sup>341</sup> This behavior is what underlies the cognitive frame Tierney labels the continuity heuristic.

As defined by Tierney, “The continuity heuristic refers to the tendency of people, organizations, and institutions to believe and act as if the future will resemble the past—or better put, that the future will resemble the past as socially constructed and framed.”<sup>342</sup> This leads societies to trust that “future events can be prepared for and responded to in tried-and-true ways based on past experience.”<sup>343</sup> As a result society negates the use of foresight and instead relies on hindsight. This is a critical oversight when planning for future disasters caused by emerging threats due to changing population demographics, economic trends and technological advances.<sup>344</sup>

Another issue discussed in the *Social Roots of Risk* is the concept of the tendency of “organizations to think primarily in probabilistic rather than ‘possibilistic’ terms.”<sup>345</sup> In probabilistic thinking, the focus is on the “socially constructed likelihood of disaster, possibilistic reasoning is concerned with the impacts that could occur as a consequence of disaster events...even if those impacts are unlikely.”<sup>346</sup> Possibilistic reasoning, therefore, focuses not only on what is likely to happen but also on the worst that could happen. The failure to respond adequately to Hurricane Katrina is used as an example of the dangers of employing probabilistic thinking to disaster planning.

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<sup>339</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, location 182.

<sup>340</sup> Ibid., location 1301.

<sup>341</sup> Ibid., location 1301–1317.

<sup>342</sup> Ibid., location 1317.

<sup>343</sup> Ibid.

<sup>344</sup> Ibid., location 1349.

<sup>345</sup> Ibid., location 1365.

<sup>346</sup> Ibid.

It would appear that approaching disasters from the perspective of the continuity heuristic (planning based on historical knowledge), when coupled with possibilistic reasoning (anticipating the worst that could happen), would result in an operative model for the development of effective homeland security policies to reduce the consequences of disasters. However, Kathleen Tierney proposes another framework that directly counters this model. It is the framework that is based on a cultural mode that “permits and even encourages practices that contribute to risk buildup, sometimes inadvertently but often intentionally.”<sup>347</sup> These practices are most apparent when viewed from the perspective of economic and political systems.

According to Tierney, “local growth machine coalitions exert political power in ways that often result in opposition to risk-aware land-use planning and the growth of vulnerability in hazardous places.”<sup>348</sup> As proof of this behavior, she offers the example of local governments that offer incentives and subsidies for land development in areas that are prone to flooding. While “levees are touted as offering protection from flooding, even in places like Greater New Orleans and the Northern California Delta, where levees offer minimal protection at best.”<sup>349</sup> This is known as “rent-seeking” and is defined as “the fact or practice of manipulating public policy or economic conditions as a strategy for increasing profits.”<sup>350</sup> In these cases, profits are realized by the promoters “while transferring future losses to homeowners, businesses, insurance and reinsurance companies, and ultimately taxpayers.”<sup>351</sup> Unfortunately, these losses are not limited to economics but also result in loss of life, damages to personal property and the environment and disruption in the social stability of a community.

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<sup>347</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, location 3900–3917.

<sup>348</sup> *Ibid.*, location 3980.

<sup>349</sup> *Ibid.*

<sup>350</sup> *Oxford Dictionaries*, s.v. “rent-seeking,” accessed March 6, 2016, [http://www.oxforddictionaries.com/us/definition/american\\_english/rent-seeking?q=rent+seeking](http://www.oxforddictionaries.com/us/definition/american_english/rent-seeking?q=rent+seeking).

<sup>351</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, location 3980.

## **E. A REVIEW OF THE PROGRESSION OF SIGNIFICANT HOMELAND SECURITY POLICIES**

Since the early 1800s, disasters have been the driving force for the evolution of homeland security practices, authorities and policies. The examples in Table 8 provide a historical perspective showing the correlation between major disasters and changes in the homeland security discipline. It is not intended to reflect the entire spectrum of authorities related to this discipline.

Table 8. Progression of Significant Homeland Security Policies

<b>Year</b>	<b>Event</b>	<b>Result</b>
1803	Portsmouth NH Fire	Federal Disaster Loans for Repair and Reconstruction of public structures.
1927	Great Mississippi Flood of 1928	Flood Control Act of 1928—authorizes the U.S. Army Corps of Engineers to design and construct projects “for the control of the floods of the Mississippi River and of the Sacramento River, California.” <sup>352</sup>
1936	Destructive nationwide flooding in 1935—1936	Flood Control Act of 1936 increases the authority of the U.S. Army Corps of Engineers to design and construct projects for flood control.
1964	Alaska Earthquake	Federal Disaster Assistance Administration—established by the Department of Housing and Urban Development, allows housing and other forms of disaster aid.
1965	Hurricane Betsy	Congress passed the National Flood Insurance Act of 1968 that allows federally guaranteed flood insurance for homeowners.
1971	San Fernando Earthquake of 1971	National Earthquake Hazards Reduction Act of 1977—enacted to reduce the risk to earthquakes by establishing and maintaining an earthquake hazards reduction program.
1972	Tropical Storm Agnes, Rapid City South Dakota Flash Floods	Flood Disaster Protection Act of 1973—requires purchase of a flood insurance policy by anyone receiving federally related financing involving flood prone property.

<sup>352</sup> Flood Control Act of 1928, ch. 569, 45 Stat. 534 ( 33 U.S.C. 702a et seq.), May 15, 1928, accessed July 5, 2015, [http://www.mvd.usace.army.mil/Portals/52/docs/MRC/Appendix\\_E.\\_1928\\_Flood\\_Control\\_Act.pdf](http://www.mvd.usace.army.mil/Portals/52/docs/MRC/Appendix_E._1928_Flood_Control_Act.pdf).

Year	Event	Result
1974	“Terrible Tuesday”—Tornadoes in 10 States	Disaster Relief Act of 1974—establishes the process for requesting a Presidential Disaster.
1970s	Love Canal, Three Mile Island, multiple natural disasters	Executive order 12127, April 1979—President Carter establishes the Federal Emergency Management Agency. <sup>353</sup>
1988	Mount St. Helen’s Eruption	Robert T. Stafford Disaster Relief and Emergency Assistance Act—amends the Disaster Relief Act of 1974, establishes the Federal 75% and Non-Federal 25% cost share for Federal public disaster assistance programs, provides States and local jurisdictions funding for disaster management, provides hazard mitigation grant funding, and authorizes Federal disaster assistance regardless of cause.
1992	Hurricane Andrew	Emergency Management Assistance Compact—national mutual aid agreements between states that was signed into law in 1996.
1993	Great Midwest Floods of 1993	National Flood Insurance Reform Act of 1994—creates the Flood Mitigation Assistance Program and the Flood Mitigation Assistance Grant Program.
1994	Northridge Earthquake	Project Impact—encouraged communities to adopt better building practices and codes, and to develop community and private-sector involvement.
1995	Alfred P. Murrah Federal Building Bombing	Antiterrorism and Effective Death Penalty Act of 1996—requires Department of Justice and FEMA to train metropolitan firefighters who respond to incidents caused by weapons of mass destruction.
2001	9/11 World Trade Center/Pentagon Attacks	Homeland Security Act of 2002—Creation of the Department of Homeland Security 2003 and transfers the functions of FEMA to DHS’ Directorate of Emergency Preparedness and Response.
2005	Hurricane Katrina	Post-Katrina Emergency Reform Act of 2006—amends the Homeland Security Act of 2002. Establishes FEMA as a distinct agency within

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<sup>353</sup> President Carter created the Federal Emergency Management Agency by consolidating several agencies. For more information on these agencies see page 7 in the *Federal Emergency Management Agency Publication 1*, November 2010, [http://www.fema.gov/media-library-data/20130726-1823-25045-8164/pub\\_1\\_final.pdf](http://www.fema.gov/media-library-data/20130726-1823-25045-8164/pub_1_final.pdf).



Year	Event	Result
		DHS.
2013	Hurricane Sandy	Sandy Recovery Improvement Act of 2013—revises the Robert T. Stafford Disaster Relief and Emergency Assistance Act. <sup>354</sup>

Each of the examples in Table 8 support the underlying premise in the policy framework’s discussed above, that homeland security in the United States historically takes a retro-focused approach and practitioners plan and make changes based on the lessons learned in the last great disaster. There is a clear correlation that these disasters meet some, if not all, of Claire Rubin’s major focusing events as catalysts for change. They also confirm Donald Kettl’s principle that change is brought about by stresses to the political system and his assertion that bureaucracies do not adequately address unknown unknowns and, therefore, we are destined to repeatedly experience catastrophic consequences from disasters. Some of these authorities and policies were developed using probabilistic reasoning and rent-seeking as described in Tierney’s philosophy. These also verify Kettl’s premise of the inadequacy of preparation for unknown unknowns. This is especially true when considering policies governing flood control projects in the United States.

The approach taken in the early days of flood control are examples of the application of these principles. In 1824, the Supreme Court ruled “that it was constitutional for the federal government to finance and construct river improvements.”<sup>355</sup> This decision led to a number of initiatives including the Flood Control Act of 1936 that authorized flood control projects and “reflected a philosophy

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<sup>354</sup> The Sandy Recovery Improvement Act of 2013 revised the Robert T. Stafford Disaster Relief and Emergency Assistance Act most notably by establishing new alternative procedures for administering the Public Assistance program; revising the provisions of the Hazard Mitigation Grant program to allow for 25 percent of funding to be advanced; directing FEMA to update the factors considered when assessing the need for Individual Assistance in the declaration process; and authorizing the chief executive of a tribal government to request disaster or emergency declarations directly from the president. Information on the act can be found at the Library of Congress, accessed October 18, 2013, <http://beta.congress.gov/bill/113th/house-bill/219>.

<sup>355</sup> David Butler, “The Expanding Role of the Federal Government: 1927–1950,” in *Emergency Management: The American Experience, 1900–2010*, 2<sup>nd</sup> ed., ed. Claire B. Rubin (Boca Raton, FL: CRC Press, 2012), 52, Kindle edition.

that man could control nature, thereby eliminating the risk of floods.”<sup>356</sup> Some of the structures constructed as flood control measures such as “levees represent a particular challenge in that they may encourage development in flood-prone areas, but sometimes fail or are overtopped by significant storms.”<sup>357</sup> Paradoxically, “the Nation’s risk in terms of lives lost, economic disruption, and property damage is increased by overconfidence in the level and reliability of structural flood protection.”<sup>358</sup> This overconfidence was proved ill-advised when devastating riverine floods impacted the Midwest in 1993 and 2008; and again during coastal flooding in Hurricane Katrina in 2005. Many of the flood control systems within the United States:

Were built decades ago using the available data, technologies, and scientific knowledge of the period that may have underestimated flood hazards for particular areas. Similarly, there are issues with changes in risk over time due to processes such as land loss, subsidence, sea-level rise, reduced natural buffers, urban development and infrastructure aging.<sup>359</sup>

This is compounded by the practice of constructing levee systems and floodwalls to withstand a 1 percent-annual-chance flood (also known as a 100-year flood)<sup>360</sup> and/or a Category 3 hurricane.<sup>361</sup> In the Midwest Flood of 1993, 1,083 levees failed or overtopped<sup>362</sup> contributing to 48 deaths, economic losses of \$30.2 billion, and more than

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<sup>356</sup> George D. Haddow and Jane A. Bullock, *Introduction to Emergency Management*, 2<sup>nd</sup> ed. (Burlington, MA: Elsevier Butterworth-Heinemann, 2006), 2.

<sup>357</sup> Betsy A. Cody and Nicole T. Carter, *Flood Risk Management and Levees: A Federal Primer* (CRS Report No. RL33129) (Washington, DC: Congressional Research Service, 2008), summary, accessed July 7, 2015 [http://digital.library.unt.edu/ark:/67531/metadc94013/m1/1/high\\_res\\_d/RL33129\\_2008Jun20.pdf](http://digital.library.unt.edu/ark:/67531/metadc94013/m1/1/high_res_d/RL33129_2008Jun20.pdf).

<sup>358</sup> *Ibid.*, 6.

<sup>359</sup> *Ibid.*, 7.

<sup>360</sup> The United States Geological Survey explanation of a 100-year flood: “The term ‘100-year flood’ is misleading because it leads people to believe that it happens only once every 100 years. The truth is that an uncommonly big flood can happen any year. The term ‘100-year flood’ is really a statistical designation, and there is a 1-in-100 chance that a flood this size will happen during any year. Perhaps a better term would be the ‘1-in-100 chance flood,’” accessed July 7, 2015, <http://pubs.usgs.gov/fs/FS-229-96/>.

<sup>361</sup> Betsy A. Cody, *Flood Risk Management and Levees: A Federal Primer*, 5–6.

<sup>362</sup> The number of failed or overtopped levees was compiled from data presented by Lee W. Larson, NOAA/National Weather Service “Great USA Flood of 1993,” paper presented at the IAHS Conference, Anaheim CA, June 24–28, 1996, [http://www.nwrhc.noaa.gov/floods/papers/oh\\_2/great.htm](http://www.nwrhc.noaa.gov/floods/papers/oh_2/great.htm).

70,000 homes damaged.<sup>363</sup> During the 2008 flood “41 levees overtopped.”<sup>364</sup> Although the losses were less than in 1993, they were still significant and are estimated at \$15.0 billion with 24 deaths.”<sup>365</sup>

Hurricane Katrina in 2005 is another example. “The failure of levees and floodwalls that protect the City of New Orleans resulted in catastrophic flooding in the Greater New Orleans area, with floodwaters in many areas up to 8 feet above the lowest floor of the building.”<sup>366</sup> It is reported that in “New Orleans alone, 134,000 housing units—70 percent of all occupied units—suffered damage from Hurricane Katrina and the subsequent flooding.”<sup>367</sup> The loss of life that is attributed to Katrina is staggering:

Sixty-five percent of the Hurricane Katrina victims in Louisiana died of injury or drowning. The majority of these deaths occurred in Eastern Orleans Parish, specifically the lower ninth ward; in Lakeview and Gentilly, adjacent to Lake Pontchartrain; and in St. Bernard Parish. Drowning and injury-related deaths occurred predominantly near levee infrastructure breaches.<sup>368</sup>

## F. CONCLUSION

This chapter presents the frameworks of three policy experts in the field of homeland security. Each of them asserts that the genesis of authorities, policies, and practices follow a long-standing tradition of planning based on the last major disaster. Claire Rubin proposes that policy development occurs as a result of incidents that share some or all of the characteristics she identifies as intrinsic to major focusing events for

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<sup>363</sup> Nicole T. Carter, *Federal Flood Policy Challenges: Lessons from the 2008 Midwest Flood* (CRS Report No. R40201) (Washington, DC: Congressional Research Service, 2009), 8, accessed July 7, 2015, [http://www.floods.org/PDF/2008\\_MidwestFloods/CR\\_Lessons\\_Learned\\_from\\_the\\_2008\\_Midwest\\_Flood.pdf](http://www.floods.org/PDF/2008_MidwestFloods/CR_Lessons_Learned_from_the_2008_Midwest_Flood.pdf).

<sup>364</sup> *Ibid.*, 11.

<sup>365</sup> Nicole T. Carter, *Federal Flood Policy Challenges: Lessons from the 2008 Midwest Flood*, 8.

<sup>366</sup> “Hurricane Katrina in the Gulf Coast: Mitigation Assessment Team Report, Building Performance Observations, Recommendations and Technical Guidance,” Federal Emergency Management Agency, FEMA 549/July 2006, vi, [http://www.fema.gov/media-library-data/20130726-1520-20490-4067/549\\_cvr\\_toc.pdf](http://www.fema.gov/media-library-data/20130726-1520-20490-4067/549_cvr_toc.pdf).

<sup>367</sup> Allison Plyer, “Facts for Features: Katrina Impact,” The Data Center, accessed July 7, 2015, <http://www.datacenterresearch.org/data-resources/katrina/facts-for-impact/>.

<sup>368</sup> Joan Brunkard, Gonza Namulanda, and Raoult Ratard, “Hurricane Katrina Deaths, Louisiana, 2005,” *Disaster Medicine and Public Health Preparedness* (August 28, 2008): 3, [http://www.dhh.state.la.us/assets/docs/katrina/deceasedreports/KatrinaDeaths\\_082008.pdf](http://www.dhh.state.la.us/assets/docs/katrina/deceasedreports/KatrinaDeaths_082008.pdf).

change. Kathleen Tierney approaches policy development from the standpoint that changes are generated based on a society's perception of risk that encourages probabilistic rather than possibilistic reasoning. She also contends that this behavior, when coupled with the practice of rent-seeking, results in catastrophic consequences that could otherwise have been avoided.

Finally, Donald Kettl also takes the position that changes are dependent on the perception of risk. He then argues changes are fashioned by stresses to the policy system. However, despite the stress agent, governments continue to be adept at planning for known knowns and known unknowns but prove inadequate in addressing unknown unknowns. This argument highlights a lack of foresight in disaster planning that echo's Tierney's probabilistic reasoning frame.

The next and concluding chapter presents my findings and recommendations as a result of conducting research to answer this question: Are slow-onset disasters adequately addressed within the homeland security discipline?

## VII. FINDINGS, RECOMMENDATIONS, FUTURE RESEARCH AND CLOSING THOUGHTS

The future depends on what you do today.

—Mahatma Gandhi

### A. INTRODUCTION

The genesis of the research that culminates in this thesis was to gain a deeper understanding of slow-onset disasters and whether they pose an emerging and distinct threat to our nation. My quest for answers began when I discovered trends associated with climate change are recognized as threats to homeland security.<sup>369</sup> These threats include natural disasters with a defined incident period that occur with little or no warning, such as hurricanes, floods, and winter storms. Each of these is widely recognized by the emergency management community and are adequately addressed by current homeland security policies and practices. However, *the State-by-State Reports: President Obama’s Plan to Cut Carbon Pollution and Prepare for Consequences of Climate Change*<sup>370</sup> published in April 2014 also identifies emerging threats that do not fall within the same category. My interest in these threats led me to identify a subset as slow-onset disasters for further study—melting Arctic ice, drought, ocean acidification, and sea-level rise.

### B. SUMMARY OF FINDINGS

#### 1. Slow-Onset Disasters Pose a Threat Homeland Security

Slow-onset disasters demonstrate early warning signs, take years to fully emerge, and trigger cascading consequences beyond primary impact zones. An analysis of existing literature on melting Arctic ice, drought, ocean acidification, and sea-level rise

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<sup>369</sup> “The 2014 Quadrennial Homeland Security Review,” United States Department of Homeland Security, 21–22.

<sup>370</sup> “State-by-State Reports: President Obama’s Plan to Cut Carbon Pollution and Prepare for Consequences of Climate Change,” The White House.

validates the direct threats they pose to the social, physical, and economic stability of local communities. This information was also used for a risk assessment that reveals drought and sea-level rise pose credible threats to the critical infrastructure lifeline sectors. This finding is significant because these sectors provide “indispensable services that enable the continuous operation of critical business and government functions, and would risk human health and safety or national and economic security if compromised or not promptly restored.”<sup>371</sup>

## **2. The Nation’s Approach to Homeland Security Does Not Adequately Address Slow-Onset Disasters**

Following my determination of the verifiable threats these hazards pose, I performed an analysis of current homeland security policies to ascertain whether or not they adequately addressed these hazards. This analysis reveals internal contradictions in the nation’s approach to homeland security hinders activities to protect against, respond to, and recover from disasters caused by melting Arctic ice, drought, ocean acidification, and sea-level rise. This conclusion is based on two findings.

First, the Stafford Act identifies a major disaster as “any natural catastrophe...in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act.”<sup>372</sup> The implementing regulations for the Stafford Act, Emergency Management and Assistance, 44 CFR §206.32(f) limits disaster assistance to damages that occurred during “the incident period or was in anticipation of that incident.”<sup>373</sup> This precludes slow-onset disasters from receiving a disaster declaration under the Stafford Act because of the difficulty in identifying a definitive incident period due to their characteristic of slow emergence.

Second, homeland security is defined as “a concerted national effort to ensure a homeland that is safe, secure, and resilient against terrorism and other hazards where

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<sup>371</sup> “Strengthening Regional Resilience, Final Report and Recommendations,” National Infrastructure Advisory Council, November 21, 2013, 14.

<sup>372</sup> *Ibid.*, 6.

<sup>373</sup> Emergency Management and Assistance, 44 CFR §206.32(f) (2002).

American interests, aspirations, and way of life can thrive.”<sup>374</sup> The National Preparedness Goal is to achieve “a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk.”<sup>375</sup> State, local, and tribal jurisdictions are eligible to receive funding through the Homeland Security Grant Program “to prevent terrorism and other catastrophic events and to prepare the nation for the threats and hazards that pose the greatest risk to the security of the United States.”<sup>376</sup> Chapters II and IV validate slow-onset disasters as threats to “American interests, aspirations and way of life.”<sup>377</sup> Therefore, the definition and goal should apply to slow-onset disasters. However, the Strategic National Risk Assessment that was performed to identify the “greatest risk to the security of the Nation”<sup>378</sup> excluded slow-onset disasters because they do not have a “distinct beginning and end.”<sup>379</sup> The 2015 National Security Strategy identified climate change as “an urgent and growing threat to our national security...contributing to increased natural disasters.”<sup>380</sup> Yet only 22 percent of the \$1.6 billion allocated for the Fiscal Year 2016 federal preparedness grants could be used for melting Arctic ice, drought, ocean acidification, and sea-level rise that are associated with climate change. The remaining funding is either limited to protecting our borders; direct counter-terrorism activities; or for activities “where a nexus to terrorism exists.”<sup>381</sup>

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<sup>374</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U. S. Department of Homeland Security, February 2010, 13.

<sup>375</sup> DHS National Preparedness Goal, September 2011, 1, [http://www.fema.gov/media-library-data/20130726-1828-25045-9470/national\\_preparedness\\_goal\\_2011.pdf](http://www.fema.gov/media-library-data/20130726-1828-25045-9470/national_preparedness_goal_2011.pdf).

<sup>376</sup> “Notice of Funding Opportunity, Fiscal Year 2016 Homeland Security Grant Program (HSGP),” U.S. Department of Homeland Security, 2, accessed April 23, 2016, [http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY\\_2016\\_HSGP\\_NOFO\\_FINAL.pdf](http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY_2016_HSGP_NOFO_FINAL.pdf).

<sup>377</sup> “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland,” U. S. Department of Homeland Security, 13.

<sup>378</sup> “National Strategic Risk Assessment,” Federal Emergency Management Agency, 1.

<sup>379</sup> *Ibid.*, 2.

<sup>380</sup> “National Security Strategy,” The White House, February 2015, 12.

<sup>381</sup> “Notice of Funding Opportunity, Fiscal Year 2016 Homeland Security Grant Program (HSGP),” U.S. Department of Homeland Security, 2.

### 3. The Framing of Homeland Security Policies

Chapter VI presents my research on the work of three experts in the field of homeland security—Claire Rubin, Donald Kettl, and Kathleen Tierney—to determine how contradictions in the nation’s approach to homeland security could occur. Each agree that homeland security authorities, policies, and practices follow a retro-focused approach of planning for the next disaster based on the events of the last. This behavior is defined by Kathleen Tierney as the continuity heuristic, “the tendency of people, organizations, and institutions to believe and act as if the future will resemble the past.”<sup>382</sup> Claire Rubin’s principle of major focusing events for change complements this concept by proposing “virtually all major federal laws, executive directives, programs, policies, organizational changes, and response systems have resulted from major and catastrophic disasters.”<sup>383</sup> Donald Kettl’s work also supports the retro-focused approach with his theory that changes occur as result of a policy system’s reaction to stress.<sup>384</sup> Chapter V of this work verifies a retro-focused framework underlies our nation’s approach to homeland security. In one case, our experience with natural disasters has led us to the expectation that disasters will always have a distinct incident period. In the other, the terrorist attacks of 9/11 have created an environment where the availability of resources to counter the threats of terrorism surpasses those for natural disasters.

Federal policies are also framed using probabilistic thinking and focuses primarily on a “socially constructed likelihood of disaster.”<sup>385</sup> This perspective leads disaster planners to consider what is most likely to happen based on a society’s risk perception. Consequence management of slow-onset disasters is an emerging issue that deserves the attention of emergency management professionals. However, the many unknown unknowns associated with their consequences require possibilistic reasoning to develop

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<sup>382</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, location 1317.

<sup>383</sup> Claire B. Rubin, “Introduction: 110 Years of Disaster Response in and Emergency Management in the United States,” 6–7.

<sup>384</sup> Donald F. Kettl, *System Under Stress: The Challenge to 21<sup>st</sup> Century Governance*.

<sup>385</sup> Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, location 1365.



policies and approaches that consider not only the likelihood of an occurrence but also the worst that could happen.

#### **4. Indicators of Change in the Nation's Approach to Slow-Onset Disasters**

FEMA's Strategic Foresight Initiative is a strategic planning effort within the emergency management community. In 2011, the initiative identified nine drivers for change that are "likely to affect the field of emergency management significantly over the next 15 years."<sup>386</sup> As I discussed in Chapter V, emergency management is a critical component of the homeland security discipline because it creates the frameworks to reduce our vulnerabilities to threats and builds our resiliency so we can recover.<sup>387</sup> Therefore, these nine drivers will also impact the homeland security discipline. Climate change is one of identified drivers.

Since the findings of the Strategic Foresight Initiative were published there have been indications that the federal government is re-evaluating its approach to climate change. This statement is substantiated by several actions. Executive Order 13653: Preparing the United States for the Impact of Climate Change was issued in 2013 and directs federal agencies "to take a series of steps to make it easier for American communities to strengthen their resilience to extreme weather and prepare for other impacts of climate change."<sup>388</sup> The Executive Order specifically identifies: removing barriers to investments for building resiliency to climate change; reforming policies and federal funding programs that increase vulnerability to climate change; and providing incentives for climate-resilient investments.<sup>389</sup> The 2015 Hazard Mitigation Grant Program includes the provision for mitigation projects to address "more powerful storms,

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<sup>386</sup> "Summary of Findings," Federal Emergency Management Agency, Strategic Foresight Initiative, 1.

<sup>387</sup> Waugh and Tierney, *Emergency Management*, 17.

<sup>388</sup> "Climate Change Resilience," The White House, Council on Environmental Quality.

<sup>389</sup> Exec. Order No. 13653 (2013).

frequent heavy precipitation, heat waves, prolonged droughts, extreme flooding, higher sea levels, and other weather events.”<sup>390</sup>

## **C. RECOMMENDATIONS**

Current events indicate the federal government is reconsidering its approach to climate change including consideration of slow-onset disasters. However, the thought processes that were used in the past for homeland security policies must be reframed if this endeavor is to be successful. The emerging threats presented by slow-onset disasters require a future-focused framework rather than the continuity heuristic. This is critical at this juncture because of the emerging drivers for change identified by the Strategic Foresight Initiative: changing population demographics, economic trends and technological advances. Instead of probabilistic thinking, disaster planners must now apply possibilistic reasoning to fully anticipate the worst that can happen as a result of the cascading consequences from melting Arctic ice, drought, ocean acidification and sea level rise.

## **D. FUTURE RESEARCH**

My research is only one effort to categorize the threats posed to homeland security by climate change. Other aspects of climate change and its implications for homeland security still warrant future research. Two of these are identified in the *2014 Quadrennial Homeland Security Review*—climate change induced pandemics and climate change as threat multipliers for terrorist activities.<sup>391</sup> The validity of both topics is still hotly debated within the homeland security discipline. Future research could resolve the issue. Instead of arguing these issues precious time would be saved, which could be used, to become more prepared to safeguard our nation against credible threats to our security.

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<sup>390</sup> “Hazard Mitigation Guidance: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and Flood Mitigation Assistance Program,” Federal Emergency Management Agency, 38.

<sup>391</sup> “The 2014 Quadrennial Homeland Security Review,” U.S. Department of Homeland Security, 21–22.

## **E. FINAL THOUGHTS**

The principles of emergency management rest on the belief that all disasters start at the local level, as do the activities taken for prevention, protection, mitigation, response, and recovery. However, the direct and indirect consequences of slow-onset disasters span large geographic areas and crosses jurisdictional boundaries. This requires the homeland security community to consider activities beyond a local perspective. A National Academies of Science report supports this approach when it cautions that “an uncoordinated approach to [climate change] adaptation in the United States would result in a patchwork of activities that may lead to unintended consequences, conflicting mandates, and potential maladaptations.”<sup>392</sup>

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<sup>392</sup> National Research Council of the National Academies of Science, *Adapting to the Impacts of Climate Change* (Washington, DC: The National Academies Press, 2010), 222, [http://www.nap.edu/catalog.php?record\\_id=12783](http://www.nap.edu/catalog.php?record_id=12783).

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## LIST OF REFERENCES

- Adelsman, Hedia, and Laura Whitely Binder, eds. *Ocean Acidification: From Knowledge to Action* (Publication no. 12–01-015). Olympia, WA: Washington State Blue Ribbon Panel on Ocean Acidification, 2012. [http://pmel.noaa.gov/co2/files/wa\\_state\\_blue\\_ribbon\\_panel\\_oa\\_11-27-2012.pdf](http://pmel.noaa.gov/co2/files/wa_state_blue_ribbon_panel_oa_11-27-2012.pdf).
- American Society of Civil Engineers. “2013 Report Card for America’s Infrastructure.” <http://www.infrastructurereportcard.org/a/#p/home>.
- Bovarnick, Ben, Shiva Polefka, and Arpita Bhattacharyya. *Rising Waters, Rising Threat: How Climate Change Endangers America’s Neglected Wastewater Infrastructure*. Washington, DC: Center for American Progress, October 2014. <https://cdn.americanprogress.org/wp-content/uploads/2014/10/wastewater-report.pdf>.
- Bissell, Rick. *Preparedness and Response for Catastrophic Disasters*. Boca Raton, FL: CRC Press, 2013.
- Bronen, Robin. *Climate-Induced Displacement of Alaska Native Communities*. Washington, DC: Brookings-Bern Project on Internal Displacement, 2013. <http://www.brookings.edu/~media/research/files/papers/2013/1/30-arctic-alaska-bronen/30-climate-alaska-bronen-paper.pdf>.
- Brunkard, Joan, Gonza Namulanda, and Raoult Ratard. “Hurricane Katrina Deaths, Louisiana, 2005.” *Disaster Medicine and Public Health Preparedness* (August 28, 2008). [http://www.dhh.state.la.us/assets/docs/katrina/deceasedreports/KatrinaDeaths\\_082008.pdf](http://www.dhh.state.la.us/assets/docs/katrina/deceasedreports/KatrinaDeaths_082008.pdf).
- Burkett, Virginia R., Robert C. Hyman, Ron Hagelman, Stephen B. Hartley, Matthew Sheppard, Thomas W. Doyle, Daniel M. Beagan, Alan Meyers, David T. Hunt, Michael K. Maynard, Russell H. Henk, Edward J. Seymour, Leslie E. Olson, Joanne R. Potter, and Nanda N. Srinivasan. “Why Study the Gulf Coasts?” In *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I*, edited by Michael J. Savonis, Virginia R. Burkett, and Joanne R. Potter. Washington, DC: Department of Transportation, 2008. <http://downloads.globalchange.gov/sap/sap4-7/sap4-7-final-all.pdf>.
- Butler, David. “The Expanding Role of the Federal Government: 1927–1950.” In *Emergency Management: The American Experience, 1900–2010*, 2<sup>nd</sup> ed., edited by Claire B. Rubin, 51–81. Boca Raton, FL: CRC Press, 2012, Kindle edition.

- Carter, Nicole T. *Federal Flood Policy Challenges: Lessons from the 2008 Midwest Flood* (CRS Report No. R40201). Washington, DC: Congressional Research Service, 2009. [http://www.floods.org/PDF/2008\\_MidwestFloods/CR\\_Lessons\\_Learned\\_from\\_the\\_2008\\_Midwest\\_Flood.pdf](http://www.floods.org/PDF/2008_MidwestFloods/CR_Lessons_Learned_from_the_2008_Midwest_Flood.pdf).
- Chapin III, F. Stewart, Sarah F. Trainor, Patricia Cochran, Henry Huntington, Carl Markon, Molly McCammon, A. David McGuire, and Mark Serreze. "Alaska." In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by Jerry M. Melillo, Terese (T. C.) Richmond, and Gary W. Yohe, 514–536. Washington, DC: U.S. Global Change Research Program, 2014. <http://nca2014.globalchange.gov/report/regions/alaska>.
- Climate Central. "Sea Level Rise Threats to Energy Sector." <http://slr.s3.amazonaws.com/SLR-Threats-to-Energy-Infrastructure.pdf>.
- . "Rain Needed to Bust the Drought." <http://www.climatecentral.org/gallery/maps/rain-needed-to-bust-the-drought>.
- . "Storm Surge and Sea Level Rise: Advancing Waters." <http://www.climatecentral.org/gallery/graphics/storm-surge-and-sea-level-rise-advancing-waters>.
- . "Surging Seas." <http://sealevel.climatecentral.org/>.
- CNN. "Hurricane Sandy Fast Facts." <http://www.cnn.com/2013/07/13/world/Americas/hurricane-sandy-fast-facts/index.html>.
- Cody, Betsy A., and Nicole T. Carter. *Flood Risk Management and Levees: A Federal Primer* (CRS Report No. RL33129). Washington, DC: Congressional Research Service, 2008. [http://digital.library.unt.edu/ark:/67531/metadc94013/m1/1/high\\_res\\_d/RL33129\\_2008Jun20.pdf](http://digital.library.unt.edu/ark:/67531/metadc94013/m1/1/high_res_d/RL33129_2008Jun20.pdf).
- Cook, Benjamin I., Toby R. Ault, and Jason E. Smerdon. "Unprecedented 21st Century Drought Risk in the American Southwest and Central Plains." *Science Advances* 1, no 1 (2015): 1–7. doi: 10.1126/sciadv.1400082.
- Cook, Edward R., Richard Seager, Mark A. Cane, and David W. Stahle. "North American Drought: Reconstructions, Causes, and Consequences." *Earth-Science Reviews* 81, (2007): 93–134. <http://www.sciencedirect.com/science/article/pii/S0012825206001784>.
- Dell, Jan, Susan Tierney, Guido Franco, Richard G. Newell, Rich Richels, John Weyant, and Thomas J. Wilbanks. "Energy Supply and Use." In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe, 113–129. Washington, DC: U.S. Global Change Research Program, 2014. <http://nca2014.globalchange.gov/report/sectors/energy>.

- Donnelly, Jeffrey P., Andrea D. Hawkes, Philip Lane, Dana MacDonald, Bryan N. Shuman, Michael R. Toomey, Peter J. van Hengstum, and Jonathan D. Woodruff. "Climate Forcing of Unprecedented Intense Hurricane Activity in the Last 2000 Years." *Earth's Future* 3, no. 2 (2015): 49–65. doi:10.1002/2014EF000274. <http://onlinelibrary.wiley.com/enhanced/doi/10.1002/2014EF000274/>.
- Explore Fairbanks Alaska. "Trans-Alaska Pipeline: North Slope to the Northernmost Ice-Free Port." <http://www.explorefairbanks.com/go/energy/trans-alaska-pipeline/27>.
- Federal Communications Commission, Public Safety and Homeland Security Bureau. "Tech Topic 19: Communications Interdependencies." <https://transition.fcc.gov/pshs/techttopics/techttopics19.html>.
- Federal Emergency Management Agency, Emergency Management Institute. "Climate Resilient Mitigation Activities for Hazard Mitigation Assistance." <https://www.fema.gov/media-library/assets/documents/110202>.
- . "The Federal Emergency Management Agency Publication 1." November 2010. <http://www.fema.gov/pdf/about/pub1.pdf>.
- . "FEMA Disaster Declarations Summary—Open Government Dataset." <https://www.fema.gov/media-library/assets/documents/28318>.
- . "Hazard Mitigation Guidance: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and Flood Mitigation Assistance Program." February 27, 2015. [http://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA\\_Guidance\\_022715\\_508.pdf](http://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf).
- . "Hurricane Katrina in the Gulf Coast: Mitigation Assessment Team Report, Building Performance Observations, Recommendations and Technical Guidance." FEMA 549/July 2006. [http://www.fema.gov/media-library-data/20130726-1520-20490-4067/549\\_cvr\\_toc.pdf](http://www.fema.gov/media-library-data/20130726-1520-20490-4067/549_cvr_toc.pdf).
- . "IS-7 A Citizen's Guide to Disaster Assistance." [http://www.training.fema.gov/emiweb/downloads/is-7unit\\_3.pdf](http://www.training.fema.gov/emiweb/downloads/is-7unit_3.pdf).
- . "IS-230.a, Introduction to Hazard Mitigation." Emmitsburg, MD: Emergency Management Institute, 2010.
- . "Mission Areas." <http://www.fema.gov/mission-areas>.
- . "National Strategic Risk Assessment." [http://www.fema.gov/media-library-data/20130726-1854-25045-5035/rma\\_strategic\\_national\\_risk\\_assessment\\_ppd8\\_1\\_.pdf](http://www.fema.gov/media-library-data/20130726-1854-25045-5035/rma_strategic_national_risk_assessment_ppd8_1_.pdf).

- Federal Emergency Management Agency, Strategic Foresight Initiative. “Changing Role of the Individual: Long-term Trends and Drivers and Their Implications for Emergency Management.” August 2011. [http://www.fema.gov/media-library-data/1402509850071-ecde32290a64f87e5a0a6fb4d3edf777/DISCLAIMERChanging%20Role %20of% 20the% 20Individual %20080311\\_508.pdf](http://www.fema.gov/media-library-data/1402509850071-ecde32290a64f87e5a0a6fb4d3edf777/DISCLAIMERChanging%20Role%20of%20the%20Individual%20080311_508.pdf).
- . “Climate Change: Long-term Trends and Drivers and Their Implications for Emergency Management.” [http://www.fema.gov/media-library-data/20130726-1836-25045-2700/climate\\_change\\_paper.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-2700/climate_change_paper.pdf).
- . “Crisis Response and Disaster Resilience 2030: Forging Strategic Action in an Age of Uncertainty, Progress Report Highlighting the 2010–2011 Insights of the Strategic Foresight Initiative.” [http://www.fema.gov/media-library-data/20130726-1816-25045-5167/sfi\\_report\\_13.jan.2012\\_final.docx.pdf](http://www.fema.gov/media-library-data/20130726-1816-25045-5167/sfi_report_13.jan.2012_final.docx.pdf).
- . “Summary of Findings.” [http://www.fema.gov/media-library-data/20130726-1836-25045-4146/findings\\_051111.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-4146/findings_051111.pdf).
- . “Technological Development and Dependency: Long-term Trends and Drivers and Their Implications for Emergency Management.” [http://www.fema.gov/media-library-data/20130726-1836-25045-2988/technology\\_dev\\_\\_paper.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-2988/technology_dev__paper.pdf).
- . “Universal Access to and Use of Information: Long-term Trends and Drivers and Their Implications for Emergency Management.” [http://www.fema.gov/media-library-data/20130726-1836-25045-5549/universal\\_access\\_paper\\_051011.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-5549/universal_access_paper_051011.pdf).
- . “U.S. Demographic Shifts: Long-term Trends and Drivers and Their Implications for Emergency Management.” [http://www.fema.gov/media-library-data/20130726-1836-25045-7108/demography\\_\\_paper\\_051011.pdf](http://www.fema.gov/media-library-data/20130726-1836-25045-7108/demography__paper_051011.pdf).
- . “What Is Mitigation?” <https://www.fema.gov/what-mitigation>.
- Ferris, Elizabeth. *A Complex Constellation: Displacement, Climate Change and Arctic Peoples*. Washington, DC: Brookings-LSE, Project on Internal Displacement. 2013. <http://www.brookings.edu/~media/research/files/papers/2013/1/30-arctic-ferris/30-arctic-ferris-paper.pdf>.
- Folger, Peter, Betsy A. Cody, and Nicole T. Carter. *Drought in the United States: Causes and Issues for Congress* (CRS Report No. RL34580). Washington, DC: Congressional Research Service, 2013. <http://www.fas.org/sgp/crs/misc/RL34580.pdf>.



- Freedman, Andrew. "U.S. Airports Face Increasing Threat from Rising Seas." *Climate Central*, June 18, 2013. Accessed January 27, 2016.  
<http://www.climatecentral.org/news/coastal-us-airports-face-increasing-threat-from-sea-level-rise-16126>.
- Gibbs, Linda I., and Caswell F. Holloway. *Hurricane Sandy After Action: Report and Recommendations to Mayor Michael R. Bloomberg*, May 2013.  
[http://www.nyc.gov/html/recovery/downloads/pdf/sandy\\_aar\\_5.2.13.pdf](http://www.nyc.gov/html/recovery/downloads/pdf/sandy_aar_5.2.13.pdf).
- Gillis, Justin. "Climate Efforts Falling Short, U.N. Panel Says." *New York Times*. April 13, 2014. [http://www.nytimes.com/2014/04/14/science/earth/un-climate-panel-warns-speedier-action-is-needed-to-avert-disaster.html?\\_r=0](http://www.nytimes.com/2014/04/14/science/earth/un-climate-panel-warns-speedier-action-is-needed-to-avert-disaster.html?_r=0).
- Griffin, Daniel, and Kevin J Anchukaitis. "How Unusual Is the 2012–2014 California Drought?" *Geophysical Research Letters* 41, no. 24 (2014): 9017–9023.  
<http://onlinelibrary.wiley.com.libproxy.nps.edu/dow/10.1002/2014GL062433/full>.
- Haddow, George D., and Jane A. Bullock. *Introduction to Emergency Management*. 2<sup>nd</sup> ed. Burlington, MA: Elsevier Butterworth-Heinemann, 2006.
- Heberger, Matthew, Heather Cooley, Pablo Herrera, Peter H. Gleick, and Eli Moore. *The Impacts of Sea Level Rise on the California Coast*. California Climate Change Center, 2009. <http://pacinst.org/wp-content/uploads/sites/21/2014/04/sea-level-rise.pdf>.
- Hellmuth, Molly, Peter Schultz, Judsen Bruzgul, Dana Spindler, and Heidi Pacini. *Assessment of Climate Change Risks to Energy Reliability in the WECC Region*. Washington, DC: ICF International, 2014. <https://www.wecc.biz/Reliability/Assessment-of-Climate-Change-Risks-to-Reliability-ICF-Dec-2014.pdf>.
- Howitt, Richard, Josue Medellin-Azuara, Duncan MacEwan, Jay Lund, and Daniel Sumner. *Economic Analysis of the 2014 Drought for California Agriculture*. Davis, CA: Center for Watershed Sciences, University of California-Davis, 2014.  
[https://watershed.ucdavis.edu/files/biblio/DroughtReport\\_23July2014\\_0.pdf](https://watershed.ucdavis.edu/files/biblio/DroughtReport_23July2014_0.pdf).
- Intergovernmental Panel on Climate Change Working Group III. "IPCC Factsheet: What Is the IPCC?" [http://ipcc.ch/news\\_and\\_events/docs/factsheets/FS\\_what\\_ipcc.pdf](http://ipcc.ch/news_and_events/docs/factsheets/FS_what_ipcc.pdf).
- International Federation of Red Cross and Red Crescent Societies. *Introduction to Disaster Preparedness: Disaster Preparedness Training Programme*.  
<http://www.ifrc.org/Global/Publications/disasters/all.pdf>.
- Island Institute. "Ocean Acidification: What It Is and Why It Matters Along the Maine Coast." [www.islandinstitute.org/files/Ocean+Acidification.pdf/853/](http://www.islandinstitute.org/files/Ocean+Acidification.pdf/853/).

- Jardine, Phil. "Patterns in Palaeontology: The Paleocene–Eocene Thermal Maximum." Palaeontology Online. <http://www.palaeontologyonline.com/articles/2011/the-paleocene-eocene-thermal-maximum/>.
- Karl, Thomas R., Jerry M. Melillo, and Thomas C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009. <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>.
- Kettl, Donald F. *System Under Stress: The Challenge to 21<sup>st</sup> Century Governance*. Thousand Oaks, CA: CQ Press, SAGE Publications, Ltd., 2014, Kindle edition.
- Kwasinski, Alex. *Hurricane Sandy Effects on Communications Systems (Preliminary Report)*. University of Texas at Austin PR-AK-0112-2012, 2012. <http://users.ece.utexas.edu/~kwasinski/preliminary%20telecom%20report%20v3%20comp.pdf>.
- Lowther, Alan, and Michael Liddel, eds. *Fisheries of the United States 2013* (Current Fishery Statistics No. 2013). Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service Office of Science and Technology, 2014. [http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus13/01\\_front2013.pdf](http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus13/01_front2013.pdf).
- Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, eds. *Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment*. Washington, DC: U.S. Global Change Research Program, 2014. [http://s3.amazonaws.com/nca2014/low/NCA3\\_Highlights\\_LowRes.pdf?download=1](http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download=1).
- Mileti, Dennis S. *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Washington, DC: Joseph Henry Press, 1999.
- Moser, Susan C. Margaret. A. Davidson, Paul Kirshen, Peter Mulvaney, James F. Murley, James E. Neumann, Laura Petes, and Denise Reed. "Coastal Zone Development and Ecosystems." In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe, 579–618. Washington, DC: U.S. Global Change Research Program, 2014, <http://nca2014.globalchange.gov/report/regions/coasts>.
- Moteff, John D. *Critical Infrastructures: Background, Policy and Implementation* (CRS Report No. RL30153). Washington, DC: Congressional Research Service, June 10, 2015. <http://fas.org/sgp/crs/homesecc/RL30153.pdf>.
- National Archives. "Guide to Federal Records: Records of the Federal Emergency Management Agency." <http://www.archives.gov/research/guide-fed-records/groups/311.html>.

- National Association of Manufacturers. “United States Manufacturing Facts.” Last modified December 2015. <http://www.nam.org/Data-and-Reports/State-Manufacturing-Data/State-Manufacturing-Data/December-2015/Manufacturing-Facts-United-States.pdf>.
- National Infrastructure Advisory Council. “Critical Infrastructure Security and Resilience National Research and Development Plan Final Report and Recommendations.” November 14, 2014. <http://www.dhs.gov/sites/default/files/publications/NIAC-CISR-RD-Plan-Report-Final-508.pdf>.
- . “Strengthening Regional Resilience, Final Report and Recommendations.” November 21, 2013. <http://www.dhs.gov/sites/default/files/publications/niac-regional-resilience-final-report-11-21-13-508.pdf>.
- National Integrated Drought Information System. “U.S. Drought Portal.” [www.drought.gov/drought](http://www.drought.gov/drought).
- National Oceanic and Atmospheric Administration. “Frequently Asked Questions: What Is Sea Level?” <http://tidesandcurrents.noaa.gov/sltrends/faq.htm#q1>.
- . “Introduction to Paleoclimatology.” [http://www.ncdc.noaa.gov/paleo/primer\\_study.html](http://www.ncdc.noaa.gov/paleo/primer_study.html).
- . “Is Sea Level Rising?” <http://oceanservice.noaa.gov/facts/sealevel.html>.
- . “NOAA Ocean Service Education.” <http://oceanservice.noaa.gov/education/kits/currents/03coastal4.html>.
- National Oceanic and Atmospheric Administration, National Centers for Environmental Information. “Billion-Dollar Weather/Climate Disasters: Table of Events.” <http://www.ncdc.noaa.gov/billions/events>.
- National Oceanic and Atmospheric Administration, National Weather Service, “Drought: Public Fact Sheet.” May 2008. <http://www.nws.noaa.gov/os/brochures/climate/DroughtPublic2.pdf>.
- . “Service Assessment: Hurricane/Post-Tropical Cyclone Sandy.” October 22–29, 2012, May 2013. <http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf>.
- National Oceanic and Atmospheric Administration, Office of Science and Technology. National Marine Fisheries Service. *Fisheries Economics of the U.S. 2012, Gulf of Mexico*. [http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012\\_GulfofMexico.pdf](http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012_GulfofMexico.pdf).
- National Oceanic and Atmospheric Administration, Pacific Marine Environmental Laboratory. “Ocean Acidification.” <http://pmel.noaa.gov/co2/story/Ocean+Acidification>.

- . “What Is Ocean Acidification?” <http://pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F>.
- National Research Council of the National Academies of Science. *Adapting to the Impacts of Climate Change*. Washington, DC: The National Academies Press, 2010. [http://www.nap.edu/catalog.php?record\\_id=12783](http://www.nap.edu/catalog.php?record_id=12783).
- . *Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean*. Washington, DC: The National Academies Press, 2010. [http://www.nap.edu/download.php?record\\_id=12904](http://www.nap.edu/download.php?record_id=12904).
- . *Potential Impacts of Climate Change on U.S. Transportation*. Washington, DC: Transportation Research Board. <http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf>.
- O’Rourke, Ronald. *Changes in the Arctic: Background and Issues for Congress* (CRS Report No. R41153). Washington, DC: Congressional Research Service, 2014. <http://www.fas.org/sgp/crs/misc/R41153.pdf>.
- Overland, James E., and Muyin Wang. “When Will the Summer Arctic Be Nearly Sea Ice Free?” *Geophysical Research Letters* 40 (2013): 2097–2101. <http://onlinelibrary.wiley.com/doi/10.1002/grl.50316/full>.
- Perrin, Andrew. “Social Media Usage: 2005–2015.” Pew Research Center. October 8, 2015. <http://www.pewinternet.org/2015/10/08/social-networking-usage-2005-2015/>.
- Platt, Rutherford H. *Disasters and Democracy: The Politics of Extreme Natural Events*. Washington, DC: Island Press, 1999.
- Plyer, Allison. “Facts for Features: Katrina Impact.” The Data Center. <http://www.datacenterresearch.org/data-resources/katrina/facts-for-impact/>.
- Polyak, Leonid, Richard B. Alley, John T. Andrews, Julie Brigham-Grette, Thomas M. Cronin, Dennis A. Darby, Arthur S. Dyke, Joan J. Fitzpatrick, Svend Funder, Marika Holland, Anne E. Jennings, Gifford H. Miller, Matt O’Regan, James Savelle, Mark Serreze, Kristen St. John, James W.C. White, and Eric Wolff. “History of Sea Ice in the Arctic,” *Quaternary Science Reviews* 29 (2010): 1757–1778. [http://bprc.osu.edu/geo/publications/polyak\\_etal\\_seaice\\_QSR\\_10.pdf](http://bprc.osu.edu/geo/publications/polyak_etal_seaice_QSR_10.pdf).
- Rogers, Barry G. “How Might Sea Level Be Affected by Changes in Land Ice.” National Oceanic and Atmospheric Administration. [http://www.arctic.noaa.gov/essay\\_barry.html](http://www.arctic.noaa.gov/essay_barry.html).
- Rubin, Claire B. “Introduction: 110 Years of Disaster Response in and Emergency Management in the United States.” In *Emergency Management: The American Experience, 1900–2010*, Second Edition, edited by Claire B. Rubin. Boca Raton, FL: CRC Press, 2012, Kindle edition.

- Sathaye, Jayant, Larry Dale, Peter Larsen, Gary Fitts, Kevin Koy, Sarah Lewis, and Andre Lucena. *Estimating Risk to California Energy Infrastructure from Projected Climate Change* (California Energy Commission Publication Number: CEC-500-2012-057). Berkeley, CA: Lawrence Berkeley National Laboratory, 2012. <http://www.energy.ca.gov/2012publications/CEC-500-2012-057/CEC-500-2012-057.pdf>.
- Schwartz, Henry G., Michael Meyer, Cynthia J. Burbank, Michael Kubly, Clinton Oster, John Posey, Edmond J. Russo, and Arthur Rypinski. "Transportation." In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by Jerry M. Melillo, Terese (T. C.) Richmond, and Gary W. Yohe, 130–149. Washington, DC: U.S. Global Change Research Program, 2014. <http://nca2014.globalchange.gov/report/sectors/transportation>.
- Smithsonian National Museum of Natural History. "Ocean Acidification." <http://ocean.si.edu/ocean-acidification>.
- Schwartz, Michael. "Sewage Flows After Storm Expose Flaws in System." *New York Times*. <http://www.nytimes.com/2012/11/30/nyregion/sewage-flows-after-hurricane-sandy-exposing-flaws-in-system.html>.
- Strauss, Ben, Claudia Tebaldi, and Remik Ziemlinski. "Surging Seas: Sea Level Rise, Storms, and Global Warming's Threat to the U.S. Coast." Climate Central, 2012. <http://slr.s3.amazonaws.com/SurgingSeas.pdf>.
- Sullivan, James K. "Water Sector Interdependencies Summary Report 2011." Alexandria, VA: Water Environment Federation, 2011. [http://www.wef.org/uploadedFiles/Access\\_Water\\_Knowledge/Water\\_Security\\_and\\_Emergency\\_Response/Final\\_WEF\\_Summary\\_WSI.pdf](http://www.wef.org/uploadedFiles/Access_Water_Knowledge/Water_Security_and_Emergency_Response/Final_WEF_Summary_WSI.pdf).
- Sutton, Adrienne J, ed. "NOAA Ocean and Great Lakes Acidification Research Plan." NOAA Ocean Acidification Steering Committee, 2010. [http://www.pmel.noaa.gov/co2/files/feel3500\\_without\\_budget\\_rfs.pdf](http://www.pmel.noaa.gov/co2/files/feel3500_without_budget_rfs.pdf).
- Thieler, E. Robert, and Erika S. Hammar-Klose. "National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Atlantic Coast, 1999." U.S. Geological Survey, Woods Hole, Massachusetts. 2000. <http://pubs.usgs.gov/dds/dds68/reports/gulfrep.pdf>.
- Tierney, Kathleen. *The Social Roots of Risk: Producing Disasters, Promoting Resilience*. Stanford, CA: Stanford University Press, 2014. Kindle edition.
- U.S. Department of Energy. U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather. July 2013. <http://energy.gov/sites/prod/files/2013/07/f2/20130716-Energy%20Sector%20Vulnerabilities%20Report.pdf>.

- . Office of Energy Policy and Systems Analysis. Climate Change and the U.S. Energy Sector: Regional Vulnerabilities and Resilience Solutions. October 2015. [http://www.energy.gov/sites/prod/files/2015/10/f27/Regional\\_Climate\\_Vulnerabilities\\_and\\_Resilience\\_Solutions\\_0.pdf](http://www.energy.gov/sites/prod/files/2015/10/f27/Regional_Climate_Vulnerabilities_and_Resilience_Solutions_0.pdf).
- U.S. Department of Homeland Security. “2010 Banking and Finance Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan.” <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-banking-and-finance-2010.pdf>.
- . “2010 Communications Sector-Specific Plan: An annex to the National Infrastructure Protection Plan.” <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-communications-2010-508.pdf>.
- . “2010 Defense Industrial Base Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan.” <http://www.dhs.gov/xlibrary/assets/nipp-ssp-defense-industrial-base-2010.pdf>.
- . “2010 Healthcare and Public Health Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan.” <http://www.dhs.gov/xlibrary/assets/nipp-ssp-healthcare-and-public-health-2010.pdf>.
- . “2010 Information Technology Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan.” <http://www.dhs.gov/sites/default/files/publications/IT%20Sector%20Specific%20Plan%202010.pdf>.
- . “2010 Transportation Systems Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan.” <http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation-systems-2010.pdf>.
- . “The 2014 Quadrennial Homeland Security Review.” <http://www.dhs.gov/sites/default/files/publications/qhsr/2014-QHSR.pdf>.
- . “2015 Chemical Sector-Specific Plan: An Annex to the NIPP, 2013.” <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-chemical-2015-508.pdf>.
- . “2015 Commercial Facilities Sector-Specific Plan: An Annex to the NIPP, 2013.” <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-commercial-facilities-2015-508.pdf>.
- . “2015 Critical Manufacturing Sector-Specific Plan, An Annex to the NIPP 2013.” <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-critical-manufacturing-2015-508.pdf>.
- . “2015 Dams Sector-Specific Plan: An Annex to the NIPP, 2013.” <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-dams-2015-508.pdf>.

- . “2015 Emergency Services Sector-Specific Plan: An Annex to the NIPP 2013.” <http://www.dhs.gov/sites/default/files/publications/nipp-ssp-emergency-services-2015-508.pdf>.
- . “2015 National Preparedness Report.” [http://www.fema.gov/media-library-data/1432751954859-fcaf2acc365b5a7213a38bbeb5cd1d61/2015\\_NPR\\_508c\\_20150527\\_Final.pdf](http://www.fema.gov/media-library-data/1432751954859-fcaf2acc365b5a7213a38bbeb5cd1d61/2015_NPR_508c_20150527_Final.pdf).
- . “2015 Nuclear Reactors, Materials and Waste Sector-Specific Plan: An Annex to the NIPP 2013.” <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-nuclear-2015-508.pdf>.
- . “2015 Sector-Specific Plans.” <https://www.dhs.gov/2015-sector-specific-plans#>.
- . “2015 Transportation Systems Sector-Specific Plan.” <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-transportation-systems-2015-508.pdf>.
- . “2015 Water and Wastewater Systems Sector-Specific Plan.” <http://www.dhs.gov/xlibrary/assets/nipp-ssp-water-2010.pdf>.
- . “Communications Sector.” [www.dhs.gov/communications-sector](http://www.dhs.gov/communications-sector).
- . “DHS Announces Grant Allocations for Fiscal Year (FY) 2016 Preparedness Grants,” Press Release dated February 16, 2016, <https://www.dhs.gov/news/2016/02/16/dhs-announces-funding-opportunity-fiscal-year-fy-2016-preparedness-grants>.
- . “Education Facilities Subsector Snapshot.” <http://www.dhs.gov/xlibrary/assets/nppd/nppd-ip-education-facilities-snapshot-2011.pdf>.
- . “Emergency Services Sector.” <http://www.dhs.gov/emergency-services-sector>.
- . “Energy Sector,” <http://www.dhs.gov/energy-sector>.
- . “Financial Services Sector-Specific Plan 2015.” <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-financial-services-2015-508.pdf>.
- . “Food and Agriculture Sector-Specific Plan, 2015.” <https://www.dhs.gov/sites/default/files/publications/nipp-ssp-food-ag-2015-508.pdf>.
- . “Government Facilities Sector.” <http://www.dhs.gov/government-facilities-sector>.
- . “Information Technology Sector.” <http://www.dhs.gov/information-technology-sector>.

- . “Management of Domestic Incidents, Homeland Security Presidential Directive 5.” February 28, 2003. <http://www.dhs.gov/sites/default/files/publications/Homeland%20Security%20Presidential%20Directive%205.pdf>.
- . “National Preparedness Goal.” 2<sup>nd</sup> ed. September 2015. [http://www.fema.gov/media-library-data/1443799615171-2aae90be55041740f97e8532fc680d40/National\\_Preparedness\\_Goal\\_2nd\\_Edition.pdf](http://www.fema.gov/media-library-data/1443799615171-2aae90be55041740f97e8532fc680d40/National_Preparedness_Goal_2nd_Edition.pdf).
- . “National Preparedness, Presidential Policy Directive/PPD-8.” March 30, 2011. <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>.
- . “National Preparedness System.” November 2011. [http://www.fema.gov/media-library-data/20130726-1855-25045-8110/national\\_preparedness\\_system\\_final.pdf](http://www.fema.gov/media-library-data/20130726-1855-25045-8110/national_preparedness_system_final.pdf).
- . “The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets.” February 2003. [https://www.dhs.gov/xlibrary/assets/Physical\\_Strategy.pdf](https://www.dhs.gov/xlibrary/assets/Physical_Strategy.pdf).
- . “NIPP 2013: Partnering for Critical Infrastructure Security and Resilience.” <https://www.dhs.gov/sites/default/files/publications/National-Infrastructure-Protection-Plan-2013-508.pdf>.
- . “Notice of Funding Opportunity (NOFO): Fiscal Year 2016 Emergency Management Performance Grant Program (EMPG).” [http://www.fema.gov/media-library-data/1455571902574-a84f5a1b2f450795a70cce1f5ee7b967/FY\\_2016\\_EMPG\\_NOFO\\_FINAL.pdf](http://www.fema.gov/media-library-data/1455571902574-a84f5a1b2f450795a70cce1f5ee7b967/FY_2016_EMPG_NOFO_FINAL.pdf).
- . “Notice of Funding Opportunity, Fiscal Year 2016 Homeland Security Grant Program (HSGP).” [http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY\\_2016\\_HSGP\\_NOFO\\_FINAL.pdf](http://www.fema.gov/media-library-data/1455569937218-3daa3552913b8affe0c6b5bc3b448635/FY_2016_HSGP_NOFO_FINAL.pdf).
- . “Overview of the National Planning Frameworks.” July 2014. [http://www.fema.gov/media-library-data/1406718145199-838ef5bed6355171a1f2d934c25f8ad0/FINAL\\_Overview\\_of\\_National\\_Planning\\_Frameworks\\_20140729.pdf](http://www.fema.gov/media-library-data/1406718145199-838ef5bed6355171a1f2d934c25f8ad0/FINAL_Overview_of_National_Planning_Frameworks_20140729.pdf).
- . “Pre-Disaster Mitigation Grant Program.” <http://www.fema.gov/pre-disaster-mitigation-grant-program>.
- . “Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland.” February 2010. <http://www.dhs.gov/sites/default/files/publications/2010-qhsr-report.pdf>.
- . “Risk Assessment.” <http://www.ready.gov/risk-assessment>.



- . “Transportation Systems Sector.” <http://www.dhs.gov/transportation-systems-sector>.
  - . “Water and Wastewater Systems Sector.” <http://www.dhs.gov/water-and-wastewater-systems-sector>.
  - . “Water Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan, 2010.” <http://www.dhs.gov/xlibrary/assets/nipp-ssp-water-2010.pdf>.
  - . “What Is Critical Infrastructure?” <http://www.dhs.gov/what-critical-infrastructure>.
- U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis. “Drought Impacts to Critical Infrastructure.” April 23, 2015. [http://content.govdelivery.com/attachments/USDHSFACIR/2015/04/30/file\\_attachments/386534/Drought %2BImpacts%2Bto%2BCritical %2BInfrastructure.pdf](http://content.govdelivery.com/attachments/USDHSFACIR/2015/04/30/file_attachments/386534/Drought%20Impacts%20to%20Critical%20Infrastructure.pdf).
- . “Resilience Report: Water and Wastewater Systems.” July 22, 2014. [https://www.massport.com/media/266269/Report\\_Sector-Resilience-Report-Water-and-Wastewater.pdf](https://www.massport.com/media/266269/Report_Sector-Resilience-Report-Water-and-Wastewater.pdf).
- U.S. Department of the Interior. “Federal Subsistence Management Program.” <https://www.doi.gov/subsistence>.
- U.S. Department of Transportation. “Climate Impacts and U.S. Transportation: Technical Input Report for the National Climate Assessment.” Draft. February 2012 (OST/P-33). <http://data.globalchange.gov/file/b59e7402-064e-4a01-8a5c-5c7f7235eb31>.
- U.S. Energy Information Administration. “Electricity Explained: Use of Electricity.” [http://www.eia.gov/energyexplained/index.cfm?page=electricity\\_use](http://www.eia.gov/energyexplained/index.cfm?page=electricity_use).
- . “How Much Gasoline Does the United States Consume?” <http://www.eia.gov/tools/faqs/faq.cfm?id=23&t=10>.
  - . “Natural Gas Explained: Use of Natural Gas.” [http://www.eia.gov/energyexplained/index.cfm?page=natural\\_gas\\_use](http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_use).
  - . “Table 3.7c Petroleum Consumption: Transportation and Electric Power Sectors.” [http://www.eia.gov/totalenergy/data/monthly/pdf/sec3\\_21.pdf](http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_21.pdf).
  - . “What Are the Major Sources and Users of Energy in the United States?” [http://www.eia.gov/energy\\_in\\_brief/article/major\\_energy\\_sources\\_and\\_users.cfm](http://www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm).
  - . “What Is the Role of Coal in the United States?” [http://www.eia.gov/energy\\_in\\_brief/article/role\\_coal\\_us.cfm](http://www.eia.gov/energy_in_brief/article/role_coal_us.cfm).

- United States Environmental Protection Agency. "Alaska: Climate Impacts in Alaska." <https://www3.epa.gov/climatechange/impacts/alaska.html>.
- . "Climate Change." [http://epa.gov/climate change/](http://epa.gov/climate%20change/).
- . "Climate Change Impacts and Adaptation." <http://www.epa.gov/climatechange/impacts-adaptation/alaska.html>.
- . "Climate Change Indicators in the United States." 2012. <http://www.epa.gov/climatechange/pdfs/climateindicators-full-2012.pdf>.
- . "Climate Change Indicators in the United States: Tropical Cyclone Activity." [https://www3.epa.gov/climatechange/pdfs/print\\_cyclones-2015.pdf](https://www3.epa.gov/climatechange/pdfs/print_cyclones-2015.pdf).
- . "Climate Impacts on Water Resources." <https://www3.epa.gov/climatechange/impacts/water.html>.
- University of Nebraska-Lincoln. "National Drought Mitigation Center." <http://drought.unl.edu/>.
- University of Nebraska-Lincoln, National Drought Mitigation Center. "Drought in the Dust Bowl Years." <http://drought.unl.edu/DroughtBasics/DustBowl/DroughtintheDustBowlYears.aspx>.
- . "The Dust Bowl's Legacy." <http://drought.unl.edu/DroughtBasics/DustBowl/TheDustBowlsLegacy.aspx>.
- University of Washington School of Oceanography. "Center for Environmental Visualization." [http://www.cev.washington.edu/story/Ocean\\_Acidification\\_Illustrations.html](http://www.cev.washington.edu/story/Ocean_Acidification_Illustrations.html).
- Upton, Harold F., and Peter Folger. *Ocean Acidification* (CRS Report No. R40143). Washington, DC: Congressional Research Service, 2013. <http://www.fas.org/sgp/crs/misc/R40143.pdf>.
- Waugh, William L. *Living with Hazards Dealing with Disasters: An Introduction to Emergency Management*. Armonk, NY: M.E. Sharpe, Inc., 2000.
- Waugh, William L. Jr., and Tierney, Kathleen, eds. *Emergency Management: Principles and Practice for Local Government*. 2nd ed. Washington, DC: International City/County Management Association, 2007.
- White House, The. "Long Term Drought Resilience: Federal Action Plan of the National Drought Resilience Partnership." March 2016. [https://www.whitehouse.gov/sites/default/files/docs/drought\\_resilience\\_action\\_plan\\_2016\\_final.pdf](https://www.whitehouse.gov/sites/default/files/docs/drought_resilience_action_plan_2016_final.pdf).

- . “National Security Strategy.” February 2015. [https://www.whitehouse.gov/sites/default/files/docs/2015\\_national\\_security\\_strategy.pdf](https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf).
- . “State-by-State Reports: President Obama’s Plan to Cut Carbon Pollution and Prepare for Consequences of Climate Change.” <http://www.whitehouse.gov/blog/2013/06/26/state-state-reports-president-obamas-plan-cut-carbon-pollution-and-prepare-consequen#states>.
- White House, The, Council on Environmental Quality. “Climate Change Resilience.” <https://www.whitehouse.gov/administration/eop/ceq/initiatives/resilience>.
- White, Roy E. “Memo on Sea Level Rise and Hazard Mitigation Assistance Programs.” Federal Emergency Management Agency, Emergency Management Institute. <http://www.fema.gov/media-library-data/1387903153505-99696bdb497c9e03bca73a97f98550e8/HMA%20Sea%20Level%20Rise%20Cover%20Memo%2012-23-13.pdf>.
- Wilhite, Donald A., Mark D. Svoboda, and Michael J. Hayes. “Understanding the Complex Impacts of Drought: A Key to Enhancing Drought Mitigation and Preparedness.” *Water Resources Management*, 21 (2007): 763–774 <http://www.geo.utexas.edu/courses/387h/Lectures/Drought.pdf>.
- Woods Hole Oceanographic Institute. “Ocean Acidification.” <http://www.whoi.edu/main/topic/ocean-acidification>.
- World Health Organization. “Definitions: Emergencies.” <http://www.who.int/hac/about/definitions/en/>.
- Zimmer, Carl. “An Ominous Warning on the Effects of Ocean Acidification.” Yale environment360. [http://e360.yale.edu/feature/an\\_ominous\\_warning\\_on\\_the\\_effects\\_of\\_ocean\\_acidification/2241/](http://e360.yale.edu/feature/an_ominous_warning_on_the_effects_of_ocean_acidification/2241/).

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